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Review of existing global guidelines, policies, and methodologies for the study of impact of windmills on birds and bats: requirements in India

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EDITORIAL

Season's greetings to our readers!! I take great pleasure in introducing you to our latest issue of *Buceros*. As you may have already seen from a glance at the cover, it is a technical review document by a team of BNHS scientists. Over the years, the BNHS has been involved in various research projects, the latest addition to the list is the study of impact of windmills on birds and bats.

This document *Review of existing global guidelines, policies, and methodologies for the study of impact of windmills on birds and bats: requirements in India* is the result of compilation of such studies conducted all over the world and a few preliminary surveys of existing and potential windmill sites, conducted by a team of BNHS scientists with regard to avifauna and bats. Towards the end of the document, step-wise mitigation measures to reduce impacts of windmill projects on birds and bats in an Indian perspective have been proposed.

Though this is a technical document, different from the normal format of the newsletter, we are hopeful that it proves to be an interesting read as it has data compiled from various international and national studies done on wind farm development and a detailed review of the Indian scenario.

Happy reading!

Divya Warrier
Scientist-In-Charge

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Guidelines on reducing impacts of windmills on birds and bats by California Energy Commission and California Fish and Game (2007), as well as BirdLife South Africa/ Endangered Wildlife Trust (Jenkins *et al.* 2011) were used for the preparation of the manuscript with kind permission of Ian Barber, Partner Development Officer - Asia and Daniel Pullan, International Site Casework Officer, the Royal Society for the Protection of Birds (RSPB), Genevieve Broad, Biodiversity Officer, Suffolk Biodiversity Partnership, UK. Reports of the Centre for Wind Energy Technology, Chennai (http://www.cwet.tn.nic.in and http://www.cwet.res.in) were used to source the data about the windmill installations in India. We are grateful to the numerous photographers who have readily shared their photographs in support of this document. We are also thankful to Dr. Deepak Apte, Chief Operating Officer, BNHS for providing his valuable inputs. Lastly, we are grateful to Ministry of Environment and Forests (MoEF), for their continuous support and guidance.

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Review of existing global guidelines, policies, and methodologies for the study of impact of windmills on birds and bats: requirements in India

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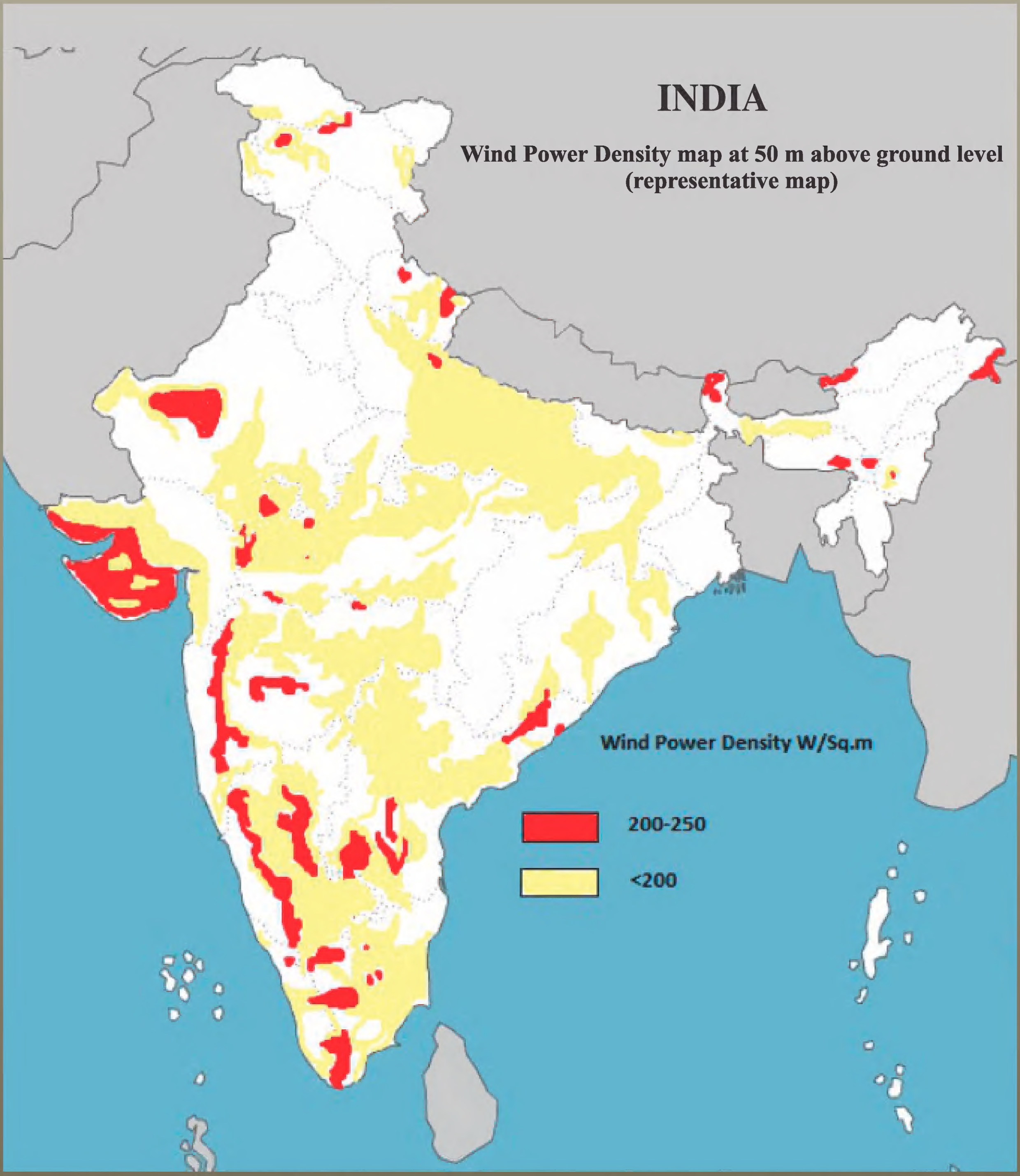


Map 1: A representative map of wind power density in India where red-coloured areas are high priority sites for installation of windmills (Based on: Centre for Wind Energy Technology (C-WET) Annual Report for 2009–10) http://www.cwet.tn.nic.in/Docu/Annual_report/English/Annual_Report_2009_2010_English.pdf and http://www.arcgis.com/home/webmap/viewer.html?webmap=9f143ec5ea6f413dbce315a30f68116f&extent=36.4107,0.3924,128.3443,43.0987

Abbreviations used in the document

IUCN - International Union for Conservation of Nature
IBCN - Indian Bird Conservation Network
USFWS - United States Fish and Wildlife Services
WPA - Wildlife Protection Act
EIA - Environmental Impact Assessment
CIA - Cumulative Impact Assessment
SEA - Strategic Environment Assessment
EMP - Environmental Management Plan
C-WET - Centre for Wind Energy Technology
MNRE - Ministry of New & Renewable Energy

Review of existing global guidelines, policies, and methodologies for the study of impact of windmills on birds and bats: requirements in India

Photo : Sujit Narwade

Introduction

Background

In view of the country's energy security, in the early 1980s, the Department of Non-Conventional Energy Sources (DNES) came into existence with the aim to reduce the dependency on primary energy sources such as coal and oil. The DNES became Ministry of Non-Conventional Energy Sources (MNES) in the year 1992, and in 2006 was renamed as Ministry of New and Renewable Energy (MNRE).

The growth of Renewable Energy in India is enormous and Wind Energy proves to be the most effective solution to the problem of depleting fossil fuels, import of coal, greenhouse gas emission, and environmental pollution. Wind energy as a renewable, non-polluting, and affordable resource, is non-dependent on fuel and transport, and can lead to generation of green and clean electricity.

With an installed capacity of 19 GW (March 2013) of wind energy, Renewable Energy Sources (excluding large hydroelectric projects) currently account for 12.5% i.e. 27.5 GW of India's overall installed power capacity. Wind Energy holds the major portion of 70% among renewable and continuous largest suppliers of clean energy. In its 12th Five Year Plan (2012–2017), Government of India has set a target of adding 18.5 GW of renewable energy resources to the generation of electricity. Out of this 11 GW is estimated to be sourced from wind energy and rest from renewable sources such as solar (4 GW) and others (3.5 GW) [Sources: 1. Report of The Working Group on Power for Twelfth Plan 2012–17, Ministry of Power, Government of India 2012, 2. C-WET reports, and 3. MNRE reports].

Our purpose is to provide researchers, consultants, decision-makers, and other stakeholders the worldwide existing guidelines and methods for investigating birds and bats in relation to utility-scale wind-energy development. The primary objectives of such studies are to 1) assess potential impacts on resident and migratory species, 2) quantify fatality rates on resident and migratory populations, 3) determine the causes of bird and bat fatalities, and 4) develop, assess, and implement methods for reducing risks to bird and bat populations and their habitats.

Sparse vegetation, scarce population, and high wind velocity in grasslands/scrubland like the ones above make them easy targets of wind energy harnessing projects

The purpose of the guidelines is to outline recommendations to reduce the impacts on wildlife. This document focuses primarily on bat and bird species because wind energy development has a huge impact on them. However, wind energy development may leave an impact on other wildlife species as well. For example, *Chinkara* or Indian Gazelle are particularly sensitive to human-caused habitat modifications and fragmentation (e.g. roads, mechanical movement). Most of the windmills are coming up in areas rich in wind energy such as ridges and slopes. For example, at present windmills are established on slopes in Kachchh area, Western Ghats, Satpuda, and have been planned in the entire Indian region on Balaghat ranges, ridges of the Deccan peninsula, east and west coastal lines of India, Thar desert, Ladakh, Northeast India, Lakshadweep and Andaman and Nicobar islands (see Map 1).

Wind energy and wildlife

Rapid wind energy development in India has raised significant challenges and opportunities in wildlife management. Such challenges include the large size and extensive placement of turbines, which may represent potential hazards to birds and bats, and the associated infrastructure required to support large number of roads and transmission lines can result in extensive habitat fragmentation and spread of invasive species.

Wind-powered turbines generating electricity are helpful in achieving greener energy with no pollution. Despite these positive features, constructing massive numbers of wind-powered turbines, or wind energy developments popularly called windmills have the potential to leave an impact on wildlife populations, especially if their placement is without proper planning. The global growth of wind energy has outpaced our assessment of possible impacts on wildlife. There is not much literature available on comprehensive studies on impact of windmills on birds and bats in India.

Windmills comprise wind turbines, interconnecting cables, transformer stations, meteorological masts and ancillary infrastructure, including onshore access roads and visitor centres. The components of the individual turbines comprise of a tapering mast, the nacelle or hub, foundations and rotor blades. The rotor

blade length and tower height determine the proportions of the turbine (Malhotra 2011). Environmental issues associated with windmills include impacts on wildlife, habitat, wetlands, and other environmentally sensitive areas; and on water resources, soil erosion, and sedimentation. Bird and bat mortality problems associated with commercial wind turbines have already tarnished the green image of large-scale wind energy projects (Ram 2004).

There is a vital need for studies with pre- and post-construction data to determine whether wind facilities will have detrimental effects on avian groups such as raptors and other soaring birds. Already existing windmill sites should be monitored closely to measure bird mortality, analyze the factors that lead birds to fly close to turbines, and propose mitigation measures. It is well known that wind turbines kill both birds and bats, though exactly how often, when and why these deaths occur remains poorly understood (Thelander 2004). The raptor kills at Altamont Pass, California, a large wind project near the San Francisco Bay area, focused attention on the problem in the late 1980s. According to Audubon, the California Energy Commission estimates 1300 raptors, including over 100 Golden Eagle, still die at Altamont every year.

As with other sources of renewable energy, wind energy is generally believed to result in fewer environmental impacts. Wind turbines have raised issues as a problem for birds since decades (Reichenbach 2002, Phillips 1994, Winkelman 1989). Discussion was mainly about their negative effect through bird strike, and also about avoidance of windmills during breeding and migration by some bird species (Reichenbach 2002). Tree-dwelling and migrating bats were observed to be particularly impacted in the Eastern U.S. (Johnson 2004).

Wind mast installed near boundary of Rehkuri Blackbuck Sanctuary, Maharashtra

Construction of wind farms will disturb the tranquility and the anthropogenic pressure from labour during construction period will affect the thickly forested habitat and the associated fauna of Northeast India

Cases of wildlife mortality at windmill sites in India

In the Thar Desert in Rajasthan, Indian Bird Conservation Network (IBCN) members have reported bird deaths related to windmills. The fenced-off areas under windmills (closure areas) have been observed to attract small mammals and reptiles. These in turn attract birds of prey which also run the risk of colliding with the wind mills. For example, a White-backed Vulture *Gyps bengalensis*, a Critically Endangered species, was found dead at a windmill site in Mawal, Pune in 2012 (Aparna Watve and Sanjay Thakur, *pers. comm.*).

In Sangli region of northern Western Ghats of Maharashtra, an avian collision threat assessment study was carried out recently by Pande *et al.* (2013). Considering the presence of 13 wind turbines in the study area, the annual total collision rate was 25 birds. Risk zone is the region between the lowest and topmost points swept by the rotor blades or the aerial height band swept by the rotor blades. Biometric parameters such as wing span and body size were considered for calculating the hypothetical collision probability of all 27 bird species flying in the risk area. Season-wise bird collision assessment studies revealed that the maximum collision risk was in winter while it was the minimum in monsoon. 19 wildlife mortalities were found dead due to collision with the rotor blades (n=10) or electrocution (n=9) due to contact with overhead transmission lines or transformers. Asian Palm Civet *Paradoxurus hermaphroditus* was found dead in the transformers built for transmitting windmill power to the base stations. Maximum collision risks for raptors were observed during the monsoon. Swallows and martins were found dead in post-monsoon period. In addition, they also noticed that two Black Kite *Milvus migrans* and one Changeable Hawk Eagle *Spizaetus cirrhatus* had collided with wind masts.

There are chances that the recently developed windmill area on Thoseghar plateau, Western Ghats, Maharashtra, may affect the flyway of the once threatened Lesser Kestrel, which has been sighted in the area, probably during winter passage migration (Watve and Thakur 2004).

White-backed Vulture *Gyps bengalensis*, a Critically Endangered species, was found dead at one of the windmill areas in Mawal

Oriental Honey Buzzard *Pernis ptilorhynchus* was found dead under power lines in Harpanhalli windmill site

One Oriental Honey Buzzard *Pernis ptilorhynchus* was found dead under power lines along the windmill sites in Harpanhalli area of Davangere, Karnataka in September 2012, by the BNHS team. Carcasses of Greater Mouse-tailed Bat *Rhinopoma microphyllum* were found in Kachchh district, Gujarat on October 8, 2012 (Kumar *et al.* 2013) in one of the windmill areas. Remains of the carcasses (wing bones and feathers) of a House Crow *Corvus splendens*, unidentified egret species, Eurasian Collared Dove *Streptopelia decaocto,* and Spotted Dove *Spilopelia chinensis* were found and an injured Blue Rock Pigeon *Columba livia* was also observed in windmill areas of Kachchh, Gujarat (Kumar *et al.* 2013).

Mortality due to high tension wires

Eight injured and 35 dead Sarus Crane were recovered between January 1999 and June 2002 at Etawah and Mainpuri districts, Uttar Pradesh, India (Sundar and Choudhury 2005). In a recent study conducted on flamingo mortality due to collision with high tension electric wires between 2002 and 2005, Rann of Kachchh (breeding site) and Gulf of Kachchh (feeding areas) Gujarat, India, 76 dead Lesser Flamingo *Phoeniconaias minor* and Greater Flamingo *Phoenicopterus roseus* were reported (Tere and Parasharya 2011). Gruiformes, particularly cranes, are at high risk of mortality due to electrical wires (Bevanger 1998).

Flamingos, like other large-bodied bird species, also are at high risk of colliding with transmission lines

Carcass of a Great Hornbill *Buceros bicornis* on a plateau

Many times carcasses of birds go unnoticed. (Above) a raptor carcass

Chapter II

Detrimental effects of wind turbines on birds and bats

Overall impacts of windmills on birds and bats were observed by Carolyn Weed from the Centerville Township Commercial Wind Ordinance Committee on wind turbine environmental issues (Weed 2006).

1) Collision of birds and bats with moving blades, tower, and associated infrastructure: Collision deaths are particularly detrimental to long-lived, slow reproducing species (eagles and bats), loss of which is non-compensatory.
2) Disturbance, displacement, exclusion from the area around wind turbines that may be caused by turbines, vehicles, people, and/or construction.
3) Barriers to movement and avoidance, disruption of feeding, breeding, and migration of birds and bats.
4) Change or loss of habitat.
5) Changes in behaviour.
6) Damage, disturbance, or destruction of foraging habitats, roosting areas, and commuting corridors.
7) Disorientation of bats in flight through emission of ultrasound noise.

2.1. *Collision mortality*

The primary emphasis of most of the windmill-wildlife research in the world has been devoted to how windmill development has impacted bird and, to a lesser extent, bat populations, and the primary emphasis of these studies has been to quantify collision mortality with wind turbines. Direct mortality or lethal injury of birds can result not only from collisions with rotors, but also with towers, nacelles, and associated structures such as guy cables, power lines, and meteorological masts. There is also evidence of birds being forced to the ground by being drawn into the vortex created by moving rotors (Winkelman 1992a, 1992b).

2.1.1. *Passerines*

Most of the research that has been completed in Europe and the United States indicates that passerines, particularly nocturnal migrants, suffer the most collision fatalities at wind farms regardless of what type of habitats the windmills are constructed in (Osborn *et al.* 2000; Mabee *et al.* 2006; Kerns and Kerlinger 2004). According to Erickson *et al.* (2002), passerines comprised 82% of all bird collision mortalities at windmills outside of California, USA. Collision mortality estimates vary from site to site.

Photo : Parveen Shaikh
Navi Mumbai, Maharashtra, May 2012

Although mortality has been the main focus of avian research at wind farms, equal importance should be given to disturbance caused due to windmills on the breeding, foraging, and roosting areas of birds

2.1.2. *Water bird, wetlands, and offshore sites*

A number of pre-development studies in Europe suggest that wind farm development could lead to the displacement of migrating and breeding waterfowl and shorebirds. This may be due to disturbance associated with wind farm construction and post-construction maintenance (Christensen *et al*. 2004, Kaiser *et al*. 2007), disruption of daily movements (Drewitt and Langston 2006), or disruption of migration activity (Drewitt and Langston 2006). More information is required regarding measures to be implemented post construction of windmills. The additional energy required by birds to avoid wind turbines could have cumulative negative impacts on them (Langston and Pullan 2003). For example, Desholm *et al.* (2005) and Kahlert *et al.* (2004) reported that the percentage of migrating waterfowl entering a windmill area decreased after construction.

2.1.3. *Collision risk*

The risk is likely to be greater on foraging and roosting sites of birds, or on migratory flyways or local flight paths, especially where the turbines intercept these species. Large birds with poor maneuverability are generally at greater risk of collision with structures (Brown *et al*. 1992) and species that habitually fly at dawn and dusk or at night are perhaps at less risk as they are likely to detect and avoid turbines (Larsen and Clausen 2002). Collision risk may also vary for a particular species, depending on age, behaviour, and stage of annual cycle. For example, terns making regular foraging flights to provision chicks are more susceptible to collision with overhead wires because they tend to fly closer to the structures at this stage (Henderson *et al*. 1996).

In some cases, the number of bat carcasses retrieved considerably outnumbers those of birds (e.g., Kerns and Kerlinger 2004, Piorkowski 2006). Recent research has shown that bats appear to actively investigate turbine rotors (Horn *et al*. 2008), probably assessing them as potential roosting/foraging sites. Horn *et al*. (2008) and Ahlén (2004) have found evidence of foraging activity around turbines. Areas of high insect density attract bats (Nicholls and Racey 2007) and are much more likely to begin hunting when large numbers of insects are congregating (Griffin *et al*. 1960). Reports on bat-turbine interactions frequently state the importance of investigation into the possibility of insect attraction to turbines, particularly since the recent loss of feeding habitats may be pressurizing bats to feed in alternative areas (Long *et al*. 2010).

Photo : Sujit Narwade
Solapur, Maharashtra, September 2007

Changes in distribution and population of reptiles in and around windmill areas as well as their association with presence or absence of raptors, needs to be studied properly. (Above) Fan-throated Lizard *Sitana ponticeriana*

Photo : Parveen Shaikh
Ahmednagar, Maharashtra, November 2012

A mortality rate of 0.19 individuals per turbine per year has been reported in Common Kestrel *Falco tinnunculus* at Straits of Gibraltar. In India, Common Kestrel is mainly found in dryland areas perching atop electric poles

2.1.4. *Recorded collision rates in raptors*

Some of the highest levels of raptor mortality were observed at Altamont Pass in California (Howell and Di Donato 1991, Orloff and Flannery 1992) and at Tarifa and Navarre in Spain (Barrios and Rodríguez 2004). Mortality of raptors is of particular concern because it affects relatively rare and long-lived species such as Griffon Vulture *Gyps fulvus* and Golden Eagle *Aquila chrysaetos*, which have low reproductive rates and are vulnerable to additive mortality.

Even low levels of mortality may be significant for long-lived species with low productivity and slow maturation rates, especially when rare species of conservation concern are affected. In such cases there could be significant impacts at the population level (locally, regionally, or in the case of threatened and restricted-range species, nationally), particularly in situations where cumulative mortality takes place due to multiple installations.

In the Straits of Gibraltar, one of the most important migration bottlenecks between Europe and Africa, mortality caused by turbines was higher than that caused by power lines. Losses involved mainly resident species, mostly Griffon Vulture (0.15 individual/turbine/year) and Common Kestrel *Falco tinnunculus* (0·19 individuals/turbine/year). There was no clear relationship between species mortality and species abundance, although all large bird collision victims were raptors and Griffon Vulture was most frequently killed (Lucas *et al.* 2008). Bird mortality and bird abundance varied noticeably among seasons, but mortality was not highest in the season with highest bird abundance. Mortality rates of Griffon Vulture did not vary significantly between years. Bird collision probability depends on species, turbine height (taller = more victims) and elevation above sea level (higher = more victims), implicating species-specific and topographic factors in collision mortality. There was no evidence of an association between collision probability and turbine type or the position of a turbine in a row (Lucas *et al.* 2008).

2.2. *Displacement due to disturbance*

The displacement of birds from areas within and surrounding windmills due to visual intrusion and disturbance can amount effectively to habitat loss. Displacement may occur during both the construction and operational phases of windmills, and may be caused by the presence of the turbines themselves through visual, noise, and vibration impacts, or because of vehicle/vessel and personnel movements related to site maintenance. The scale and degree of disturbance will vary according to site and species-specific factors and

Windmill construction will only add to the harmful effects of other habitat-altering activities threatening the Thar desert such as construction of dams and mining

they must be assessed on a site-by-site basis. Unfortunately, most studies of displacement due to disturbance are not conclusive, often because of the lack of before-and-after and control-impact assessments.

Onshore, disturbance distances upto 800 m have been recorded for wintering waterfowl (Pedersen and Poulsen 1991), though 600 m is widely accepted as the maximum reliably recorded distance. The variability of displacement distances is illustrated by a study which found lower post-construction densities of feeding European White-fronted Geese *Anser albifrons* within 600 m of the turbines at a windmill in Rheiderland, Germany (Kruckenberg and Jaene 1999). Another study showed displacement of Pink-footed Geese *Anser brachyrhynchus* up to only 100–200 m from turbines at a windmill in Denmark (Larsen and Madsen 2000).

Monitoring data from windmills located on unenclosed upland habitats in the UK were collated to test whether breeding densities of upland birds were reduced as a result of windmill construction or during windmill operation. Data were available for 10 species, although none were raptors. Red Grouse *Lagopus lagopus scoticus*, Common Snipe *Gallinago gallinago,* and Eurasian Curlew *Numenius arquata* densities all declined on construction sites of windmills during construction. Red Grouse densities recovered after construction, but Common Snipe and Eurasian Curlew densities did not. Post-construction curlew densities on windmills were also significantly lower than on reference sites. Conversely, densities of Skylark *Alauda arvensis* and Common Stonechat *Saxicola torquata* increased on windmills during construction. There was little evidence for consistent post-construction population decline in any species, suggesting for the first time that windmill construction can have greater impacts upon birds than windmill operation (Pearce-Higgins *et al.* 2012).

2.3. *Habitat loss and habitat alteration*

European conservationists generally consider the habitat loss associated with windmill development to be a greater threat to bird populations than collision fatalities. There is evidence that construction of windmills renders habitat unsuitable for birds. For example, Leddy *et al.* (1999) found that grassland bird densities were higher on grasslands without wind turbines than on areas with wind turbines. They believed that the turbines themselves and associated structures were disturbing and thus displacing birds.

Habitat loss has been the greatest threat for the survival of the Great Indian Bustard *Ardeotis nigriceps*, a dryland species. With a population of less than 250 birds in the wild, the species is now considered Critically Endangered. Numerous operational and proposed windmills and solar plants threaten bustard areas in Maharashtra, Gujarat, and Rajasthan

Construction of new roads in addition to existing ones often reduces species diversity of an area by facilitating introduction of exotic and invasive plant species and their subsequent range expansion

In addition to migratory bird and bat populations, windmill development could have negative impacts on other bird, mammal, and herpetofauna populations inhabiting wind farm development sites because these developments alter wildlife habitats in some fashion. However, such impacts are likely to be less threatening than those from other methods of energy resource extraction, such as oil and gas exploration and production, or surface mineral mining. Impacts that would occur from wind power development would be associated with the footprint resulting from construction of turbines as well as infrastructure development, such as the construction of buildings and roads, and electrical transmission lines. Habitat disturbance associated with footprints will be a function of the size and numbers of turbines that are constructed on the development site. Typically, wind turbine footprints range from 0.08 ha (0.2 acres) to 0.20 ha (0.5 acres) and compose 2–5% of windmill site (Fox *et al.* 2006). Thus, habitat disturbance from the footprint alone may not be substantial. Turbines may have created collision problems for raptors by creating habitats for small mammals, which result in increase in prey populations (Curry and Kerlinger 2000, Thelander *et al.* 2003).

Therefore, in addition to collision with turbines and collision or electrocution associated with power lines, road networks are also likely to impact wildlife populations inhabiting windmills. Trombulak and Frissell (2000) reviewed the literature relevant to road effects on terrestrial and aquatic communities. Based on the literature, they concluded that the presence of roads is associated with negative impacts on biotic integrity and could result in loss of biodiversity at local and regional levels.

Road construction and the presence of roads often reduce biodiversity by facilitating the introduction and range expansion of exotic invasive plants. For example, Rentch *et al.* (2005) found that roadsides provided optimal growing sites for exotic plants that ultimately suppress native species. For example, *Prosopis julifera* has been observed spreading all over India in disturbed habitats.

2.4. *Change in abundance and behaviour*

In a study in Wisconsin, Washington, it was observed that raptor abundance in the post-construction phase of windmills was reduced by 47% compared to pre-construction levels in a pre- and post-construction study of a windmill on the abundance and behaviour of raptors. Flight behaviour varied by species, but most individuals remained at least 100 m away from turbines and above the height of the rotor zone (Garvin *et al.* 2011).

2.5. *Barrier effect*

Birds changing their migration flyways or local flight paths to avoid a windmill is a form of displacement. This barrier effect is of concern because of the possibility of increased energy expenditure when birds have to fly further to avoid a large array of turbines, and the potential disruption of linkages between distant feeding, roosting, moulting, and breeding areas otherwise unaffected by the windmill. The effect depends on many factors such as the species, type of bird movement, flight height, distance to turbines, the layout and operational status of turbines, time of day, wind force and direction. This can be highly variable, ranging from a slight 'check' in flight direction, height or speed, through significant diversions, which may reduce the number of birds using areas beyond the windmill. Studies of bird movements in response to offshore developments have recorded wildfowl avoiding action between 100 and 3000 m from turbines (Winkelman 1992c, Christensen *et al.* 2004, Kahlert *et al.* 2004). There is limited evidence to show that nocturnally migrating waterfowl are able to detect and avoid turbines, at least in some circumstances, and that avoiding distances can be greater during darker nights (Winkelman 1992a, Dirksen *et al.* 1998, 2000)

These studies show that the scale of disturbance caused by windmills varies greatly. This variation depends on a wide range of factors including seasonal and diurnal patterns of use by birds, location with respect to important habitats, availability of alternative habitats, and perhaps also turbine and windmill specification. Behavioural responses vary not only between different species, but between individuals of the same species, depending on stage of life cycle (wintering, moulting, and breeding), flock size, and degree of habituation. The possibility that wintering birds in particular might habituate to the presence of turbines has been raised (Langston and Pullan 2003), though it is acknowledged that there is little evidence and few studies of long enough duration to show this. A recent systematic review of the effects of wind turbines on bird abundance has shown that increasing time since operation resulted in greater declines in bird abundance (Stewart *et al.* 2005). This indicates that impacts are likely to persist or worsen with time and suggests that habituation is unlikely, at least in some cases.

Barriers in the pathway of migration can force the birds to divert from their usual trajectory, thereby increasing energy expenditure

Chapter III

Overview of methodologies/policies used in ongoing research on bird and bat mortalities due to windmills

Guidelines

Anderson *et al.* (1999) guideline document describes techniques to evaluate potential windmill sites prior to the facilitation of construction, monitor post-construction impacts, assess the significance of impacts, and reduce the risk to birds. Much of the guideline focuses on experimental design, and the document recognizes that protocols for bird studies at windmills are site- and species-specific.

The USFWS issued an interim guideline on avoiding and minimizing wildlife impacts from wind energy projects (USFWS 2000). This guideline was intended to be used by Service staff providing technical assistance to the wind energy industry and focuses on pre-construction evaluation of windmill sites, turbine siting, design, and operation issues. The recommended pre-construction evaluation is based on comparing a suite of site attributes such as physical characteristics, species present, and other ecological factors at proposed windmill sites and nearby reference areas.

Techniques

The techniques which are already in use for surveying birds in windmill areas comprise visual observations for migrating diurnal raptors; acoustic monitoring for nocturnal migrants; mist-netting for migrant songbirds; and NEXRAD radar for nocturnal migrants (Kelly 2000). Visual observations on migrating diurnal raptors were designed to determine their species composition, numbers, and flight behaviour of raptors in the windmill area. Similar "hawk watches" were conducted at numerous sites throughout North America to monitor raptor numbers and for recreational purposes (Zalles and Bildstein 2000). Acoustic bird monitoring records of calls given by nocturnal migrating birds can quantify the number of birds passing over a site and often allow identification up to species or groups of species (Evans and Mellinger 1999).

Mistnetting and ringing helps in determining migrant species composition

Recent advances in automated processing have improved both the quantification and identification of recorded calls (Evans and Rosenberg 1999). The technique, however, has received limited use at windmills. Mistnetting can be an effective technique for determining the presence, species composition, and relative numbers of migrant songbirds present in an area (Ralph and Scott 1981). NEXRAD radar is an effective tool for monitoring broad-scale migration patterns including density, speed, and direction of birds (Gauthreaux and Belser 1999).

High estimates of bat mortality have seasonal patterns. Studies have also shown an inverse relationship between mortality and wind speed – more bat fatalities are observed on nights with low wind speeds. Bat activity was found to be positively related to low wind periods and higher ambient temperatures (Arnett *et al.* 2005, 2008, 2010)

Section 1: During permitting process

Provided a decision is made to permit windmills on a particular land, project proponents and permitting agencies should be familiar with the Indian Wildlife Protection Act (WPA) and International Union for Conservation of Nature (IUCN) categories of threatened species during the permitting process to ensure that impacts to wildlife are minimized and/or mitigated in order to avoid violating state and national laws.

The Critical Wildlife Habitat Policy

This policy requires to work with developers and permitting agencies in order to develop adequate mitigation plans for habitat losses resulting from land and water projects. Criteria used to classify general mitigation

Photo : Mrugank Prabhu
Ananthpur, Andhra Pradesh, November 2012

Following a mitigative Critical Wildlife Habitat Policy would benefit not only a flagship species but also the associated fauna and flora found in particular habitat such as grassland and scrubland

goals into four categories as suggested by international protocols such as Wildlife and Wildlife Habitat Compensation Policy (Arizona Game and Fish Department 2008):

A) *Resource Category I*: Habitats in this category are of the highest value to Indian wildlife species and are irreplaceable on a state-wide or regional basis.
Goal: No loss of existing in-kind habitat value.
Guideline: All potential losses of existing habitat values will be prevented. Insignificant changes may be acceptable provided that they have no significant cumulative impacts.

B) *Resource Category II*: Habitats in this category are of high value and are relatively scarce or becoming scarce on a state-wide or regional basis.
Goal: No net loss of existing habitat value, while minimizing loss of in-kind value.
Guideline: Losses to be avoided or minimized. If significant losses are likely to occur, concerned institutes can recommend alternatives to immediately rectify, reduce, or eliminate these losses over time.

C) *Resource Category III*: Habitats in this category are of high to medium value and are relatively abundant.
Goal: No net loss of habitat value.
Guideline: Concerned institutes can recommend ways to minimize or avoid habitat losses. Anticipated losses will be compensated by replacement of habitat values in-kind, or by substitution of high value habitat types, elsewhere or by increased management of replacement habitats, so no net loss occurs.

D) *Resource Category IV*: Habitats in this category are of medium to low value for wildlife, due to proximity to urban development or low productivity associated with these sites.
Goal: Minimize loss of habitat value.
Guideline: Concerned institutes can recommend ways to avoid or minimize habitat losses.

Section 2: Pre-construction phase

This phase should include surveys of birds and bats using methods suggested by California Energy Commission and California Department of Fish and Game (2007).

A) <u>Bat surveys</u>

1. *Monitoring at Roosts* – especially visual counts (Swift 1980), visual strip counts or equivalents (Gaisler 1979), mist nets and specialized Tuttle traps (Tuttle 1974). Kunz and Brock (1975) found that nets produce similar results to ultrasonic detectors at a drinking site, but this cannot be useful at feeding sites (Bell 1980).

Ultrasonic Detectors: echolocating bats emit signals that may be dominated by constant-frequency components or may sweep through a narrow or wide range of frequencies (Simmons *et al*. 1979a, 1979b).

2. *Local Experts and Other Resources* – Contacts with biologists familiar with the area, including staff from universities, colleges, birdwatchers as well as local bat experts.

3. *Developing a Pre-construction Study Plan* – This involves preparation of questionnaire about potential for sighting records of bats and birds.

4. *Nocturnal Bat Survey Methods* – The objectives of bat surveys during the pre-construction phase should be designed to determine: 1) species occurrence and diversity; 2) activity levels such as daily/seasonal timing; 3) density and abundance; and 4) potential migration pathways.

5. *Acoustic Detection for Bats* – Acoustic detection involves the use of specialized acoustic equipment to identify bat species by comparing recorded calls to a reference library of known calls (Hayes 1997). There is evidence that bats might be attracted to newly created wind developments and their associated nacelles and blades (Kunz *et al*. 2007b).

6. *Mistnetting for Bats* – Mistnetting and acoustic monitoring are complementary techniques that may be effective for getting information on bats at a particular site (O'Farrell *et al*. 1999). Assessment of colony size, demographics, and population status of bats can be done following O'Shea and Bogan (2003). Guidelines on capture techniques for bats, including mistnets and harp traps, are mentioned by Kunz *et al*. (1996).

7. *Roost Surveys for Bats* – Pre-construction survey efforts should be designed to assess occurrence of potential bat roosts such as mines, caves, bridges, buildings, etc. near proposed wind turbine sites. If active roosts are detected by signs such as guano, culled insect parts, and urine staining (Kunz *et al.* 1996), studies conducted at exit counts can provide additional information about the size, species composition, and activity patterns.

8. *Visual Monitoring of Bats* – The equipment used for recording or observing nocturnal activity includes night-vision equipment, thermal infrared equipment, and Radio Detection and Ranging (RADAR). Thermal infrared imaging cameras are designed to detect heat emitted from objects in a field of view without artificial illumination (Kunz *et al*. 2007a).

Bats such as *Rousettus leschenaultii*, which were earlier found in caves, are now also found in thousands in man-made tunnels

Project sites should be surveyed for presence of breeding grounds of threatened species. (Above) Breeding grounds of White-fronted Goose *Anser albifrons* near a wind farm in Lower Saxony, Germany

B) Bird surveys

1. *Line transects and point counts* – As basic methods of bird survey (Bibby *et al.* 1992)
2. *Diurnal Bird Survey Methods* – All survey techniques require experienced surveyors who are skilled at identifying the birds that are likely to occur in the project area. They must be proficient in estimating vertical and horizontal distances accurately.
3. *Large Bird Use Count (LBUC)* – This is a modified point count that involves the observer recording bird detections from a single vantage point for a specified time period under different weather conditions, such as windy days.
4. *Raptor Nest Searches* – Surveys should be conducted during the breeding season within a radius of at least 3 km of proposed turbine locations, to document the number of nesting pairs, activity status, and their location. Search distances can vary, depending on the target raptor species and vegetation community.
5. *Counting of Migratory Birds* – Migratory bird counts are recommended when there is evidence to suggest that the site has potential for high rates of bird migration (e.g., within or near known migratory corridors, abundance of major prey).
6. *Small Bird Use Count* (SBUCs) – These should be conducted when one or more small birds of special status or species of concern might breed in, or adjacent to, the project area.

Pre-construction surveys are required to establish the flight patterns and distribution of birds and bats at the project site. The objective of pre-construction monitoring is to document species diversity and abundance of birds and bats utilizing the habitat and airspace where the turbine(s) will be constructed. Surveys should take place on both the turbine site location and a nearby reference site or control sites. The reference site should contain similar habitat features as the impact site and surveys should be coordinated to occur, as much as possible, simultaneously at both sites.

A comprehensive analysis of present and future projects at a particular site is required to determine their cumulative impact on wildlife. (Above) Wind farms alongside cement manufacturing units

Section 3) Construction phase

Construction activities should be organized and timed to minimize impacts on wildlife from noise, disruption of habitat, and the presence of vehicles and people. Permanently accessed roads and buildings related to the construction of the site should also be considered as potential sources of disturbance or damage. Construction should take place at appropriate times to minimise impacts of noise, vibrations, lighting, and other disturbances on bats.

Cumulative Impact Analysis

A cumulative impact analysis considers a project's incremental impacts combined with the impacts of other land use changes. Assessing cumulative impacts on bats and birds is difficult because population viability data are not available for most species. An adequate analysis of cumulative impacts on special status of bat or bird species should include the following steps (California Energy Commission and California Department of Fish and Game 2007).

1. Identify the species requiring a cumulative impact analysis, including any species that are likely to suffer significant impact.
2. Establish an appropriate geographic scope for the analysis and provide a reasonable explanation for the geographic limitations used.
3. Compile a summary list of past, present, and future projects within the specified geographical range that could have an impact on the species, including construction of transmission lines and associated infrastructure. The list of projects should include other wind projects as well as other projects which may involve habitat loss, collision fatalities, or blockage of migratory routes that could have an impact on the species under consideration.
4. Assess the impacts to the relevant bat or bird species from past, present, and future projects. The analysis should use population trend information and regional analysis available for the species.
5. Identify impacts for avoidance, minimization, or mitigation measures to the species, and make an assessment regarding the significance of the project's contribution to cumulative impacts.

The determination should include an evaluation of the cumulative impacts that the project and neighbouring projects may have on the local or regional species population or the species as a whole (California Energy Commission and California Department of Fish and Game 2007).

Section 4) Post-construction monitoring and reporting

It is important to collect post-construction data at wind turbine sites and meteorological towers in order to assess and compare:

1. Wildlife data and impact estimates from the pre-construction studies,
2. Cumulative impacts from other wind energy projects,
3. Avoidance, minimization, and mitigation measures implemented in the pre-construction phase, and
4. Overall bat and bird fatality rates and how these rates relate to other projects.

In general, post-construction monitoring consists of ongoing bat and bird use surveys and counts of bat and bird carcasses in the vicinity of wind turbine bases. In order to measure best effects, post-construction monitoring data should be directly comparable to pre-construction data, therefore the same techniques should be used in both the pre- and post-construction monitoring. Post-construction monitoring should also include carcass searches and the associated searcher bias estimation.

4.1. *Determining Bat and Bird Abundance and Behaviour during Operations*

The purpose of post-construction monitoring is to obtain data that can be compared with pre-construction survey data, evaluate the effectiveness of mitigation measures, and assess fatalities at wind turbines (Kunz *et al.* 2007a).

4.2. *Estimating Fatalities of Bats and Birds*

Carcass surveys are an important tool for assessing mortality in the turbine area. Although there are multiple approaches for doing carcass searches (e.g., line transects, circular plots), they can all be scientifically reliable as long as the sampling bias is quantified (Kunz *et al.* 2007a, 2007b).

4.2.1. *Collecting Carcass Data*

Collecting bats and birds during carcass counts can provide data about the geographical source and abundance of resident and migratory populations. Record the species information, which turbine they were collected beneath (e.g., mid row or end row), and if possible, photograph the specimen.

4.2.2. *Frequency of Carcass Searches*

Since bat and bird carcasses are readily scavenged and easily overlooked, at least 30% of turbines at a given site should be searched daily during seasons when bats are most active. The results of carcass searches can be biased by the removal of carcasses by scavengers before they can be counted as well as observer bias/error (Johnson 2004). In order to better estimate the actual numbers of fatalities, carcass removal trials are required to assess the impacts of scavengers, and searcher efficiency trials to correct observer bias. Carcass removal trials are conducted by placing fresh carcasses in the search area and noting how long it takes for the carcass to be removed by a scavenger. Searcher efficiency trials involve a third party placing carcasses in the search area without the searcher knowing where they were placed. The number of carcasses detected and missed will assess each searcher's efficiency. These trials must be carried out throughout (and concurrent with) the carcass surveys, and should take place on the impact site.

4.2.3. *Search methods*

The searcher will examine each transect at a slow and regular pace, looking for fatalities on both sides of the line. The search will start an hour after sunrise, when the lighting conditions enable the searcher to distinguish dead bats.

Collecting bat and bird carcasses can provide data about the geographical source and abundance of resident and migratory populations. An unidentified flamingo carcass found under transmission lines in India (left) and a dead Hoary Bat *Lasiurus cinereus* found beneath an industrial wind turbine in the United States (right)

Chapter IV

Best mitigation measures suggested

1. Ensuring that key areas of conservation importance and sensitivity are avoided. Please check website of Integrated Biodiversity Assessment Tool (IBAT) (https://www.ibatforbusiness.org) and Important Bird Areas (http://ibcn.in/?page_id=548).
2. Avoid areas where threatened birds and bats, especially Critically Endangered, Endangered and Vulnerable birds are reported (see Annexures I and III).
3. Implementing appropriate working practices to protect sensitive habitats.
4. Providing adequate briefing for site personnel and conducting an on-site ecological study during construction, particularly in sensitive locations such as Protected Areas (PAs), Important Bird Areas (IBAs) (Islam and Rahmani 2004), World Natural Heritage Sites (see Annexure II).
5. Where possible, installing transmission cables underground (subject to habitat sensitivities and in accordance with existing best practice guidelines for underground cable installation).
6. Marking overhead cables using defectors and avoiding use over areas of high bird concentrations, especially for species vulnerable to collision.
7. Timing construction to avoid sensitive periods such as migratory and breeding seasons, and roost timings of birds and bats.
8. Implementing habitat enhancement for wildlife in general and targeted species in particular. But care should be taken not to attract species having more risk of collision in windmill areas.
9. Implement biodiversity offset elsewhere if a particular biodiversity site is unavoidable to develop.

Photo : Sujit Narwade
Ahmednagar, Maharashtra, November 2012

Construction activities should be organized and timed to minimize their impacts on wildlife. Too many constructions occurring simultaneously at a particular site may have disastrous consequences on wildlife

Wildlife research – a potential mitigation option with long-term benefits

The more knowledge about wildlife response to wind energy development, the more effective recommendations can be made to avoid/minimize/mitigate impacts. When considering research as a mitigation option, consult with nodal agency to help design and conduct investigations (Phillips 2011).

1. Monitor the movement patterns of resident raptors (e.g., nesting of raptors) prior to project construction in order to aid tower placement.
2. Identify and map the major migratory pathways of raptors and bats.
3. Determine patterns of migration (e.g., time of year, time of day) by bats and birds.
4. Identify the temporal and spatial patterns of bat activity at proposed wind energy sites.
5. Determine the effect of wind turbine size and configuration on bat and bird mortality.
6. Evaluate the movement and behaviour patterns of selected wildlife species (e.g., ungulates, grassland passerines, raptors) pre- and post-construction.
7. Evaluate the efficiency of bird strike diverters used on guyed wire towers.
8. Develop standardized before-after/control-impact study protocols for bat and bird mortality studies.
9. Identify the impacts of wind development infrastructure (e.g., roadways, high voltage wires, electrical substations) on wildlife connectivity.
10. Determine the potential effects of a proposed wind project on the demographics of selected wildlife species.
11. Identify the causes of bat and bird mortalities at wind project sites; develop and evaluate potential mitigation procedures and/or devices.

Determination of appropriate survey methodology and mitigation measures requires a thorough knowledge of the habitat and wildlife of the area to be developed

Photo : Sujit Narwade
Navi Mumbai, Maharashtra, June 2013

Photo : Sujit Narwade
Osmanabad, Maharashtra, March 2013

Possible death of birds and bats due to electrocution should be considered while planning wind farms

For site-specific mitigation, it may be necessary to prepare a site management plan designed to reduce or prevent harmful habitat changes following construction, and to provide habitat enhancement as appropriate. Other measures that may be suitable in some circumstances include the relocation of proposed or actual turbines responsible for particular problems, halting operation during peak migration periods, or reducing rotor speed. Again, post-construction monitoring is essential in order to test the effectiveness of such mitigation measures and research is required to provide more information on specific impacts and novel mitigation measures that might reduce impacts.

A total of 165 species of birds found in India are globally threatened, according to BirdLife and IUCN list of 2013 (see Annexure I). These include 16 Critically Endangered, 18 Endangered, 53 Vulnerable, 75 Near Threatened, and 3 Data Deficient species. The species for which India is an important country for their conservation have also been identified (Rahmani 2012). This list obviously includes all the endemic threatened species that occur only in India and semi-endemic species such as Sarus Crane, Lesser Florican, Great Indian Bustard, Long-billed Vulture. The bulk of the world's population of semi-endemics is found in India. This list also includes important species such as Spot-billed Pelican, Indian Skimmer, Greater Adjutant, Painted Stork, and Black-necked Stork.

Although they are found in many other countries, the major conservation action for these birds is taking place in India. If they disappear from India, their global population will be in great danger. Out of 165 globally threatened bird species found in India, for 110 species, India is extremely important for their survival. We consider that India is a 'guardian' country for them (Rahmani 2012). Care should be taken if the windmills are coming up on areas having a high population of threatened species.

Fourteen threatened species of bats have been identified by IUCN in India (see Annexure III). Though none of them come under Critically Endangered category, a thorough study of six Data Deficient bat species is needed to ascertain their status.

Chapter V

Monitoring protocols for evaluating wind energy development proposals

International monitoring protocols for evaluating wind energy development proposals discuss a four-tier assessment process (Jenkin *et al.* 2011) as mentioned below:

1. *Reconnaissance*: a brief site visit provides a desk-top assessment of likely avifauna and possible impacts, and the design of a site-specific survey and monitoring project.
2. *Baseline monitoring*: a full assessment of the significance of likely impacts and available mitigation options, based on the results of systematic and quantified monitoring (as specified at scoping).
3. *Post-construction monitoring*: duplication of the baseline work, but including the collection of mortality data, to develop a complete before and after picture of impacts, and refine the mitigation effort.
4. If required, more detailed and intensive research on affected threatened species.

5.1. *Each site visit should include:*

1. Density estimates for terrestrial birds and bats especially affected on a landscape scale by multiple developments in one area.
2. Absolute counts, density estimates or abundance indices for large terrestrial birds and raptors.
3. Passage rates of birds/bats flying through the proposed development area.
4. Occupancy/numbers/breeding success at any focal raptor sites.
5. Bird numbers at any focal wetlands.
6. Full details of any opportunistic sightings of species, on high priority.

5.2. *Post-construction monitoring*

This should effectively duplicate the baseline work with the addition of surveys for collision and electrocution victims under the turbines and ancillary power infrastructure. These guidelines should be revised periodically based on experience gained in implementing them, and ongoing input from various sectors.

Photo : Sujit Narwade
Chandrapur, Maharashtra, October 2013

Collision deaths are detrimental to long-living, slow-reproducing species, loss of which cannot be compensated, e.g., Great Indian Bustard is facing threat from habitat degradation, disturbance, and electrocution due to an increase in number of solar panels and windmills, and subsequent increase in the network of high-tension wires

Cumulative Impact Assessment studies are required in areas where wind, solar, and thermal power plants have been proposed in close proximity with each other

5.3. *Importance of Cumulative Impact Assessment (CIA) study*

Individually, a windmill, or indeed any action, may have minor effects on the environment, but collectively these may be significant, potentially greater than the sum of the individual parts acting alone. European Union and UK legislation requires a Cumulative Impact Assessment (CIA) as part of Environmental Impact Assessments (EIA). However, in the absence of detailed guidelines and definitions, such assessments within EIA are rarely adequate, restricting the acquisition of basic knowledge about the cumulative impacts of windmills on bird populations (Masden *et al.* 2009).

It is essential to follow the movement of birds having high mortality risk because of wind turbines. Study of movement and distribution of such birds is important to know their route and behaviour in relation to the upcoming development projects. Therefore satellite tracking (PTT), ringing/banding, and geolocators should be deployed on selected birds based on first year study.

The Cumulative Impact Assessment process is inadequate and unsatisfactory in the absence of effective assessments of cumulative impacts, the main cause being the current lack of guidelines (Cooper and Sheate 2004), and particularly the absence of a comprehensive definition. Without a clear definition, it is not possible to ensure an assessment that demonstrates adequate consideration of all aspects of the ecosystem including spatial and temporal scales. Therefore, there is an urgent need for legislation and statutory authorities to offer clarity on the requirements of cumulative assessment. Similarly, without explicit statements of which components have been considered in a cumulative assessment, it is difficult to draw conclusions from the data (Masden *et al.* 2009).

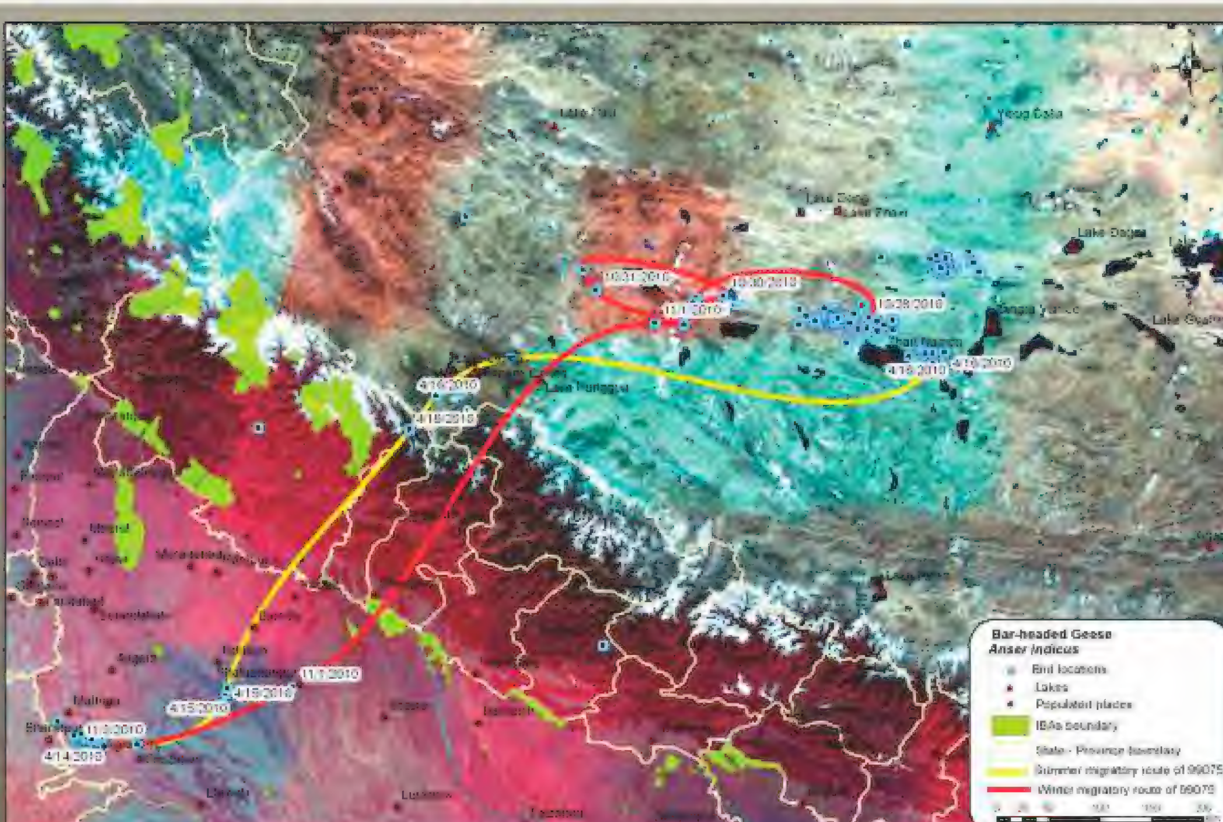
A comprehensive cumulative impact assessment relies on the availability of data for actions. In a competitive business such as energy supply, acquiring information from other developers about potential actions, sufficient to conduct a thorough cumulative assessment, is difficult. Strategic assessments already occur within the EU in the form of Strategic Environmental Assessment (SEA) and for offshore windmill developments, the SEA is intended to inform cumulative impact assessments. Therefore, the infrastructure is more readily available and would only need modification. It has been suggested that when the capability and the resources for assessing cumulative impacts are limited, a greater proportion of effort should be assigned to minimize the impacts of single actions (MacDonald 2000). The recommended shift in policy would see cumulative impact assessment integrated into strategic planning levels as part of the process of spatially

explicit planning, making available the resources of developers to minimize the impacts of single actions through environmental impact assessments (Masden *et al.* 2009).

5.4. *Data Resources for Biological Information*

Systems such as Environmental Information System (ENVIS) supported by MoEF, Government of India, is an efficient and cost-effective source of biological information. ENVIS is a national network of 66 data centres on various subjects such as avian ecology (BNHS), protected areas (Wildlife Institute of India, Dehradun), meteorology (Indian Institute of Tropical Meteorology, Pune), and Inland Wetlands (Sálim Ali Centre for Ornithology and Natural History, Coimbatore). It identifies elements of concern in India and consolidates information about their status and distribution throughout the country. For updated information on bird species, www.bnhsenvis.nic.in can be visited regularly.

Other useful sources of information are dedicated portals such as Indian Biodiversity Information Network (IBIN), and Integrated Biodiversity Assessment Tool (IBAT), Western Ghats portal. The Online Tool uses data to provide species lists based on the project area to gather initial biological data. However, obtaining a species list does not constitute a review of the project. In addition, portals data does not include potential distribution of special status species. One has to be aware that the occurrences are recorded in portals only if the site has been previously surveyed during the appropriate season, detection was made, and the observation was reported and entered into the database. The absence of occurrence data on portals should not be interpreted as absence of special status species in a specific area. It is also important to evaluate known occurrences of sensitive species and habitats near the site and in comparable adjacent areas. In addition, *Buceros* newsletter issues such as *Endemic Birds of India*, *Important Bird Areas of India,* and *Threatened Birds of India*, published by the BNHS ENVIS Centre on Avian Ecology can be used by wind developers to identify critical habitats, species, and threats to them.



It is important to find out the migratory routes of the birds and impact of windmills on their habitat use through satellite telemetry studies. This map shows the migratory route of the Bar-headed Goose Anser indicus (tagged as 99075) from Sur Sarovar Bird Sanctuary, near Agra (India) to Tibetan Plateau (China) in spring (yellow) and back in autumn (red) (Kalra *et al.* 2011)

5.5. *Site selection and configuration*

The following are the recommendations for siting wind turbines:

1. Avoid locations known for threatened species.
2. Avoid known migration paths and areas where birds congregate or are conserved.
3. Avoid areas near places known for bat hibernation, breeding, and migration corridors or flight paths between colonies and feeding areas.
4. Avoid areas and features that attract raptors and owls, quickly remove carcasses that attract predators.
5. Avoid designated wildlife Protected Areas, Important Bird Areas, Ramsar Sites, wetlands, and wildlife corridors, especially those oriented in the direction of migratory movement.
6. Avoid using or degrading high value habitat areas and avoid habitat fragmentation.
7. Minimize roads, fences, and infrastructure.
8. Configure arrays to minimize mortality by grouping and orienting rows parallel to bird movement.
9. Tower lighting can be avoided altogether by not permitting tower heights that require lighting (60 m or more) and by prohibiting other on-site lighting. There is a growing body of evidence suggesting that lights near and on towers attract birds and bats particularly during poor weather. The results of a long-term (29 year) study in Florida showed that towers less than 90 m high did not pose significant threats to migrating birds (Anon. 2004).
10. Location of power lines: Because birds are known to collide with electrical lines, the American Bird Conservancy and the USFWS (2000) recommend that power lines be installed underground in accordance with best practice guidelines.
11. Operation during seasonal migration: Highest bird and bat mortality occurs during seasonal migration. The turbines may need to be shut down during periods of high seasonal concentrations of birds. The same policy would be appropriate for migrating bats.
12. Operation during low visibility weather conditions: Highest tower mortality rates are associated with low visibility conditions, especially fog and poor weather conditions (Kingsley and Whittam 2005). Turbines should be shut down when such conditions occur and during songbird and bat migrations.

Preparation of a site management plan designed to reduce or prevent harmful habitat changes is important. (Above) A wind farm in the semi-evergreen forest of Mawal area, Pune, Maharashtra

Windmill construction on undulating slopes may affect flight paths of birds and bats

13. Experts have proposed that bat mortality may be reduced by turning turbines off or reducing blade speed during bat migration seasons when low wind and/or foggy, low visibility conditions occur. Research also suggests that birds may experience a visual smear effect that makes them less able to detect fast-moving rotor blades, although blade striping does not seem to reduce mortality.
14. Tower height/turbine size: It is not clear whether fewer taller turbines with larger rotors cause more or less mortality than larger numbers of smaller turbines. However, experience with communication towers clearly demonstrates that taller towers experience higher rates of mortality.
15. Tower and turbine design: According to the American Bird Conservancy, guy wires and lattice towers, which encourage perching and nesting, are associated with higher rates of bird mortality and should be prohibited. USFWS (2000) recommended tubular towers with pointed tops with no exterior ladders or platforms.
16. Rotational speeds of rotors: The majority of bat killings documented in Pennsylvania and West Virginia occurred on nights when average wind speeds were low, but turbine blades were moving at relatively high speeds as reported by the Bat Wind Energy Cooperative (Arnett *et al.* 2005). The echolocation abilities of migrating bats and the effect of turbine speed on echolocation are not yet fully understood.
17. Construction process: Construction activities should be organized and timed to minimize impacts on wildlife from noise, disruption of habitat, and the presence of vehicles and people.
18. Integrate the overall construction design and activities to fit the physical features of the site. Avoid fragile or unstable sites and sites that require construction activities on steep slopes.
19. Execute stage construction and stabilization activities to minimize the area and duration of disturbance.

Although impacts may occur, the ability to mitigate them can determine whether a project is to be supported further. Feasible mitigation is recommended if it will serve to minimize a project's effect on wildlife populations and their habitats. Mitigation is site- and species-specific and must be formulated for each individual project. Mitigation should have a biological basis to ensure protection or enhancement of the species affected by the project. Planning authorities can regulate the construction and operation of wind turbines by means of planning conditions and/or a planning obligation. Planning conditions and obligations can apply to a range of issues including size, nature, and location of the project. When assessing planning applications for wind turbines and when they draw up conditions or obligations, planners should be mindful of possible effects of wind turbines on birds and bats in terms of disturbance, severance of foraging or migratory routes, habitat loss or damage, and collision. Planners should also insist that monitoring is done on the impacts of the turbines.

Conclusion

A step-wise approach to bird and bat monitoring at a proposed wind energy site

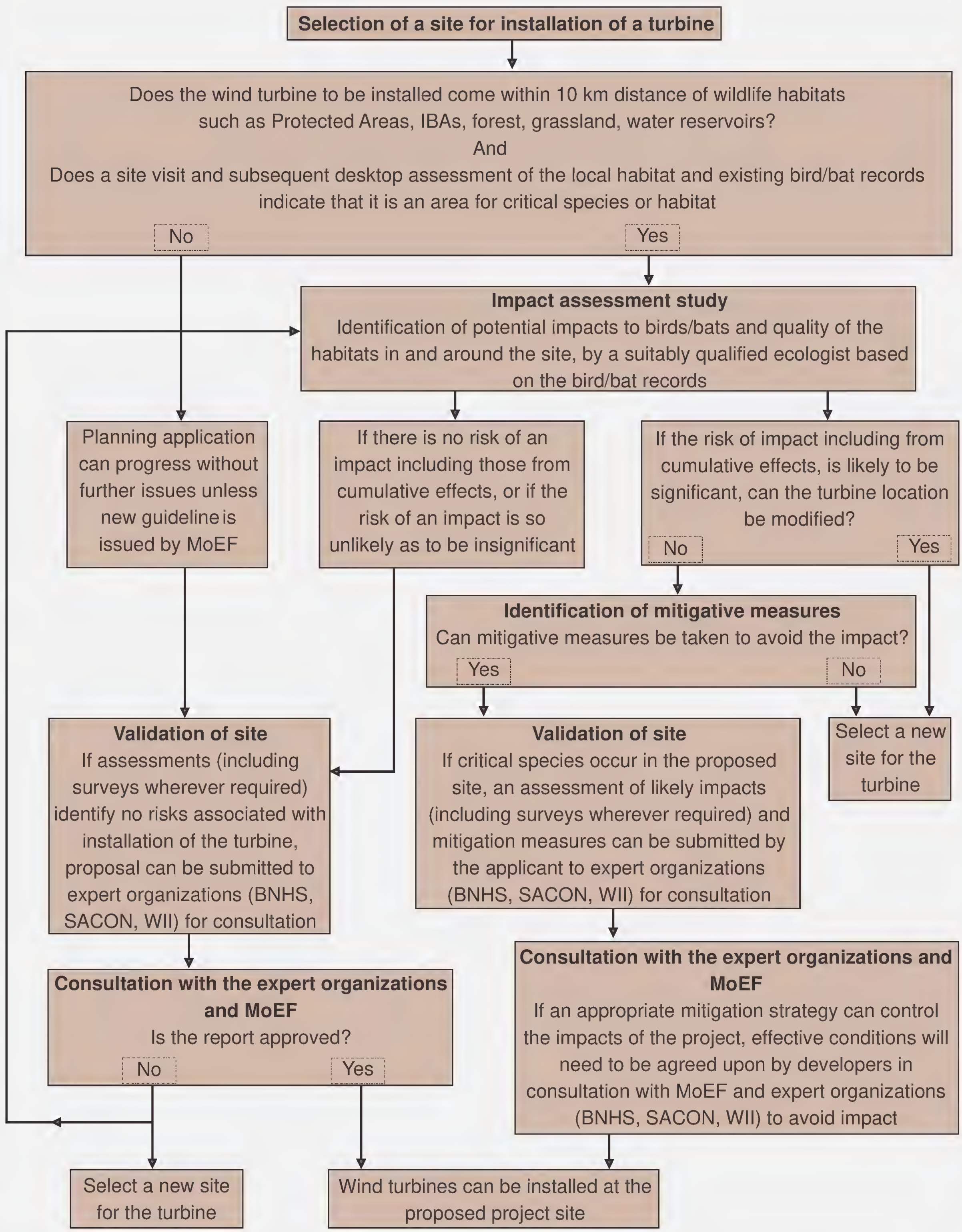
The following are the key steps in the successful design and implementation of bird and bat monitoring at a proposed wind energy development site:

1) Appoint a qualified and expert scientist for consultation and a capable monitoring agency to conduct pre- and post-construction monitoring.
2) Get the monitoring protocols right, i.e., customize the generic guidelines to suit the specific issues at each site.
3) Determine the extent of radar deployment required, if radar use is required, secure the budget, and acquire/hire hardware, software, and relevant expertise, including the appointment of a radar technologist to service the project.
4) Start baseline monitoring.
5) Periodically collate and analyze baseline-monitoring data, and adjust the data collection protocols and schedule them, to ensure that sufficient data is accumulated and sufficient coverage is achieved, to give adequate information for development decisions.
6) Compile a report reviewing the full year of baseline monitoring, and integrate these findings into the Environmental Management Plan (EMP) for the project and the broader mitigation scheme.
7) Determine whether certain anticipated impacts warrant the implementation of 'during construction' monitoring, and how this can best be achieved subject to construction schedules and activities.
8) Ensure that the EMP is applied during construction.
9) Refine the post-construction monitoring protocol in terms of the baseline work, and determine the extent of radar deployment required.
10) Start post-construction monitoring.
11) Periodically collate and analyze post-construction monitoring data, and adjust the data collection protocols and schedule to ensure that sufficient data are accumulated and sufficient coverage is achieved to adequately inform operational decisions.
12) Compile a report reviewing the full year of post-construction monitoring, integrate the findings into the EMP for the operating windmill and the broader mitigation scheme, and review the need for further post-construction monitoring.

Photo : Sujit Narwade
Ananthpur, Andhra Pradesh, November 2012

Recommended approach to assess impact of windmills on birds and bats before installation of turbines

(based on recommended approach provided by Suffolk Biodiversity Partnership Planning Support Group, UK)



Note: For windmills already in operation, study mentioned under Section 4 – post-construction monitoring – on Pg. 19 should be conducted.

Eco-sensitive Zones (ESZ) in India

During XXIst meeting of National Board of Wildlife (NBWL) held in 2002 a "Wildlife Conservation Strategy - 2002" was adapted where in point number 9 envisaged eco-fragile zones. Lands falling within 10 km radius of National Parks (NP) and Wildlife Sanctuaries (WLS) should be notified as eco-fragile zones under section 3(2)(v) of Environment (Protection) Act, 1986 (EPA) and Rule 5 clauses (v) and (viii) of Environment (Protection) Rules, 1986 (EPR). The National Wildlife Action Plan (NWAP), 2002–16 indicates that "areas outside the PA network are often vital ecological corridor links and must be protected to prevent isolation of fragments of biodiversity for its long term survival".

Further, delineation of eco-sensitive zones would have to be site-specific and related to regulation, rather than prohibition, of specific activities. ESZ should be a "shock absorber" for PAs as well as a transition zone for highly protected to less protected zones. For example, Guindy National Park and Sanjay Gandhi National Park are located in an urban setup where it is difficult to delineate the ESZ. Width of ESZ can differ according to the PA. As opposed to general principle width of 10 km around a PA as provided in Wildlife Conservation Strategy - 2002, ESZ width could be well beyond 10 km in case of sensitive corridors, connectivity of landscape linkages.

Activities such as commercial mining and use of firewood, setting up of saw mills and other polluting industries, discharge of effluents and solid waste in natural habitats, establishment of major hydroelectric projects, use or production of hazardous substances, activities like flying over the PAs by aircraft, hot air balloons, are prohibited. Activities such as felling of trees, establishment of hotels and resorts and fencing around them, drastic changes in agriculture system, commercial use of natural water reservoirs including groundwater harvesting, erection of electric cables, use of polythene bags, widening of roads, vehicular movements and pollution, introduction of exotic species, protection of hill slopes and river banks, sign boards and hoardings, are regulated activities in ESZ. Activities such as ongoing agriculture and horticulture practices by locals, rainwater harvesting, organic farming, adoption of green technology and renewable energy for all activities are permitted in ESZ areas.

ESZ declaration around 450 PAs in India is ongoing with a range of 0 to 10 km as proposed by the respective state governments and as decided by the MoEF. We urge the government to put installation of windmills in ESZ among prohibited activities.

Source - http://envfor.nic.in/eco-sensitive_zone

Eco-sensitive zones declared by the MoEF, Government of India

State	Region
Assam	Numaligarh, East of Kaziranga
Gujarat	Marine National Park, Purna Wildlife Sanctuary, Vansda National Park, Narayan Sarovar Wildlife Sanctuary, Girnar Reserve Forest
Haryana	Sultanpur National Park, Khaparwas Wildlife Sanctuary, Bhindawas Wildlife Sanctuary, Abubshaher Wildlife Sanctuary, Chhilchhila Wildlife Sanctuary, Nahar Wildlife Sanctuary, Bir Shikargarh Wildlife Sanctuary, Khol hi Raitan Wildlife Sanctuary, Kalesar National Park and Wildlife Sanctuary
Karnataka	Bandipur National Park
Madhya Pradesh	Pachmarhi
Maharashtra	Matheran and surrounding region, Dahanu Taluka, Murud-Janjira, Mahabaleshwar-Panchgani region
Rajasthan	Mount Abu, Aravalli Range
Uttar Pradesh	Taj Trapezium Zone, Doon Valley
	River Bhagirathi from Gaumukh to Uttarkashi

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Annexure I
Threatened Birds of India
(Source: BirdLife International 2013)

Sr. No.	Common Name	Species	IUCN Status 2013
1	Himalayan Quail	*Ophrysia superciliosa*	CR
2	Pink-headed Duck	*Rhodonessa caryophyllacea*	CR
3	Baer's Pochard	*Aythya baeri*	CR
4	Forest Owlet	*Heteroglaux blewitti*	CR
5	Great Indian Bustard	*Ardeotis nigriceps*	CR
6	Bengal Florican	*Houbaropsis bengalensis*	CR
7	Siberian Crane	*Leucogeranus leucogeranus*	CR
8	Spoon-billed Sandpiper	*Eurynorhynchus pygmeus*	CR
9	Sociable Lapwing	*Vanellus gregarius*	CR
10	Jerdon's Courser	*Rhinoptilus bitorquatus*	CR
11	White-rumped Vulture	*Gyps bengalensis*	CR
12	Red-headed Vulture	*Sarcogyps calvus*	CR
13	White-bellied Heron	*Ardea insignis*	CR
14	Christmas Island Frigatebird	*Fregata andrewsi*	CR
15	Slender-billed Vulture	*Gyps tenuirostris*	CR
16	Indian Vulture	*Gyps indicus*	CR
17	Green Peafowl	*Pavo muticus*	EN
18	White-headed Duck	*Oxyura leucocephala*	EN
19	White-winged Duck	*Cairina scutulata*	EN
20	Narcondam Hornbill	*Aceros narcondami*	EN
21	Lesser Florican	*Sypheotides indicus*	EN
22	Masked Finfoot	*Heliopais personatus*	EN
23	Spotted Greenshank	*Tringa guttifer*	EN
24	Black-bellied Tern	*Sterna acuticauda*	EN
25	Oriental Stork	*Ciconia boyciana*	EN
26	Greater Adjutant	*Leptoptilos dubius*	EN
27	Egyptian Vulture	*Neophron percnopterus*	EN
28	Saker Falcon	*Falco cherrug*	EN
29	Red-breasted Goose	*Branta ruficollis*	EN
30	Black-chinned Laughingthrush	*Strophocincla cachinnans*	EN
31	Nilgiri Blue Robin	*Myiomela major*	EN
32	White-bellied Blue Robin	*Myiomela albiventris*	EN
33	Yellow-breasted Bunting	*Emberiza aureola*	EN
34	Manipur Bush-quail	*Perdicula manipurensis*	EN
35	Nicobar Megapode	*Megapodius nicobariensis*	VU
36	Swamp Francolin	*Francolinus gularis*	VU
37	Chestnut-breasted Partridge	*Arborophila mandellii*	VU
38	Western Tragopan	*Tragopan melanocephalus*	VU
39	Blyth's Tragopan	*Tragopan blythii*	VU
40	Sclater's Monal	*Lophophorus sclateri*	VU
41	Cheer Pheasant	*Catreus wallichi*	VU
42	Marbled Teal	*Marmaronetta angustirostris*	VU
43	Rufous-necked Hornbill	*Aceros nipalensis*	VU
44	Dark-rumped Swift	*Apus acuticauda*	VU
45	Pale-backed Pigeon	*Columba eversmanni*	VU
46	Nilgiri Wood-pigeon	*Columba elphinstonii*	VU
47	Pale-capped Pigeon	*Columba punicea*	VU
48	Houbara Bustard	*Chlamydotis undulata*	VU
49	Sarus Crane	*Grus antigone*	VU
50	Hooded Crane	*Grus monacha*	VU

(CR: Critically Endangered; EN: Endangered; VU: Vulnerable; NT: Near Threatened, DD: Data Deficient)
For more details, refer http://www.bnhsenvis.nic.in/Forms/subjectwiselist.aspx?lid=773

Sr. No.	Common Name	Species	IUCN Status 2013
51	Black-necked Crane	*Grus nigricollis*	VU
52	Wood Snipe	*Gallinago nemoricola*	VU
53	Indian Skimmer	*Rynchops albicollis*	VU
54	Pallas's Fish-eagle	*Haliaeetus leucoryphus*	VU
55	Nicobar Sparrowhawk	*Accipiter butleri*	VU
56	Greater Spotted Eagle	*Aquila clanga*	VU
57	Eastern Imperial Eagle	*Aquila heliaca*	VU
58	Dalmatian Pelican	*Pelecanus crispus*	VU
59	Lesser Adjutant	*Leptoptilos javanicus*	VU
60	Grey-sided Thrush	*Turdus feae*	VU
61	Kashmir Flycatcher	*Ficedula subrubra*	VU
62	White-browed Bushchat	*Saxicola macrorhynchus*	VU
63	White-throated Bushchat	*Saxicola insignis*	VU
64	Beautiful Nuthatch	*Sitta formosa*	VU
65	White-naped Tit	*Parus nuchalis*	VU
66	Yellow-throated Bulbul	*Pycnonotus xantholaemus*	VU
67	Grey-crowned Prinia	*Prinia cinereocapilla*	VU
68	Bristled Grassbird	*Chaetornis striata*	VU
69	Broad-tailed Grassbird	*Schoenicola platyurus*	VU
70	Marsh Babbler	*Pellorneum palustre*	VU
71	Rusty-throated Wren-babbler	*Spelaeornis badeigularis*	VU
72	Tawny-breasted Wren-babbler	*Spelaeornis longicaudatus*	VU
73	Jerdon's Babbler	*Chrysomma altirostre*	VU
74	Slender-billed Babbler	*Turdoides longirostris*	VU
75	Black-breasted Parrotbill	*Paradoxornis flavirostris*	VU
76	Yellow Weaver	*Ploceus megarhynchus*	VU
77	Green Avadavat	*Amandava formosa*	VU
78	Socotra Cormorant	*Phalacrocorax nigrogularis*	VU
79	Snowy-throated Babbler	*Stachyris oglei*	VU
80	Nilgiri Pipit	*Anthus nilghiriensis*	VU
81	Lesser White-fronted Goose	*Anser erythropus*	VU
82	Long-tailed Duck	*Clangula hyemalis*	VU
83	Great Knot	*Calidris tenuirostris*	VU
84	Indian Spotted Eagle	*Aquila hastata*	VU
85	Great Slaty Woodpecker	*Mulleripicus pulverulentus*	VU
86	Red-faced Malkoha	*Phaenicophaeus pyrrhocephalus*	VU
87	Bugun Liocichla	*Liocichla bugunorum*	VU
88	White-cheeked Partridge	*Arborophila atrogularis*	NT
89	Satyr Tragopan	*Tragopan satyra*	NT
90	Tibetan Eared-pheasant	*Crossoptilon harmani*	NT
91	Hume's Pheasant	*Syrmaticus humiae*	NT
92	Ferruginous Duck	*Aythya nyroca*	NT
93	Yellow-rumped Honeyguide	*Indicator xanthonotus*	NT
94	Andaman Woodpecker	*Dryocopus hodgei*	NT
95	Malabar Pied Hornbill	*Anthracoceros coronatus*	NT
96	Ward's Trogon	*Harpactes wardi*	NT
97	Blyth's Kingfisher	*Alcedo hercules*	NT
98	Brown-winged Kingfisher	*Pelargopsis amauroptera*	NT
99	Derbyan Parakeet	*Psittacula derbiana*	NT
100	Nicobar Parakeet	*Psittacula caniceps*	NT
101	Andaman Scops-owl	*Otus balli*	NT
102	Andaman Hawk-owl	*Ninox affinis*	NT
103	Andaman Wood-pigeon	*Columba palumboides*	NT
104	Andaman Cuckoo-dove	*Macropygia rufipennis*	NT
105	Nicobar Pigeon	*Caloenas nicobarica*	NT
106	Andaman Crake	*Rallina canningi*	NT
107	Asian Dowitcher	*Limnodromus semipalmatus*	NT
108	Lesser Fish-eagle	*Ichthyophaga humilis*	NT
109	Grey-headed Fish-eagle	*Ichthyophaga ichthyaetus*	NT

Sr. No.	Common Name	Species	IUCN Status 2013
110	Cinereous Vulture	*Aegypius monachus*	NT
111	Andaman Serpent-eagle	*Spilornis elgini*	NT
112	Pallid Harrier	*Circus macrourus*	NT
113	Oriental Darter	*Anhinga melanogaster*	NT
114	Lesser Flamingo	*Phoeniconaias minor*	NT
115	Black-headed Ibis	*Threskiornis melanocephalus*	NT
116	Spot-billed Pelican	*Pelecanus philippensis*	NT
117	Painted Stork	*Mycteria leucocephala*	NT
118	Andaman Treepie	*Dendrocitta bayleyi*	NT
119	Andaman Drongo	*Dicrurus andamanensis*	NT
120	Rusty-bellied Shortwing	*Brachypteryx hyperythra*	NT
121	Black-and-rufous Flycatcher	*Ficedula nigrorufa*	NT
122	Nilgiri Flycatcher	*Eumyias albicaudatus*	NT
123	Firethroat	*Luscinia pectardens*	NT
124	Grey-headed Bulbul	*Pycnonotus priocephalus*	NT
125	Nicobar Bulbul	*Hypsipetes nicobariensis*	NT
126	Rufous-vented Prinia	*Prinia burnesii*	NT
127	Long-billed Bush-warbler	*Bradypterus major*	NT
128	Tytler's Leaf-warbler	*Phylloscopus tytleri*	NT
129	Chestnut-backed Laughingthrush	*Garrulax nuchalis*	NT
130	Rufous-throated Wren-babbler	*Spelaeornis caudatus*	NT
131	Giant Babax	*Babax waddelli*	NT
132	Black-necked Stork	*Ephippiorhynchus asiaticus*	NT
133	Beach Thick-knee	*Esacus giganteus*	NT
134	Great Hornbill	*Buceros bicornis*	NT
135	Rufous-rumped Grassbird	*Graminicola bengalensis*	NT
136	Long-tailed Parakeet	*Psittacula longicauda*	NT
137	Little Bustard	*Tetrax tetrax*	NT
138	Great Snipe	*Gallinago media*	NT
139	Falcated Duck	*Anas falcata*	NT
140	Black-tailed Godwit	*Limosa limosa*	NT
141	Eurasian Curlew	*Numenius arquata*	NT
142	River Lapwing	*Vanellus duvaucelii*	NT
143	River Tern	*Sterna aurantia*	NT
144	South Nicobar Serpent-eagle	*Spilornis klossi*	NT
145	Red Kite	*Milvus milvus*	NT
146	Laggar Falcon	*Falco jugger*	NT
147	Japanese Quail	*Coturnix japonica*	NT
148	European Roller	*Coracias garrulus*	NT
149	Buff-breasted Sandpiper	*Tryngites subruficollis*	NT
150	Austen's Brown Hornbill	*Anorrhinus austeni*	NT
151	Blackish-breasted Babbler	*Sphenocichla humei*	NT
152	Long-tailed Wren-babbler	*Spelaeornis chocolatinus*	NT
153	Chevron-breasted Babbler	*Sphenocichla roberti*	NT
154	Mangrove Pitta	*Pitta megarhyncha*	NT
155	Jouanin's Petrel	*Bulweria fallax*	NT
156	Swinhoe's Storm-petrel	*Oceanodroma monorhis*	NT
157	Kerala Laughingthrush	*Strophocincla fairbanki*	NT
158	Great Stone-Plover (Thick-knee)	*Esacus recurvirostris*	NT
159	Alexandrine Parakeet	*Psittacula eupatria*	NT
160	Grey-headed Parakeet	*Psittacula finschii*	NT
161	Blossom-headed Parakeet	*Psittacula roseata*	NT
162	Red-breasted Parakeet	*Psittacula alexandri*	NT
163	Nicobar Scops-owl	*Otus alius*	DD
164	Large-billed Reed-warbler	*Acrocephalus orinus*	DD
165	Sillem's Mountain-finch	*Leucosticte sillemi*	DD

Annexure II

Important Bird Areas of India

(Source: Islam and Rahmani 2004)

IBA Code	Site Name	Districts	Status
Andaman and Nicobar Islands			
IN-AN-01	Austin Strait	Andaman Islands	NOP
IN-AN-02	Baratang - Rafters Creek	Andaman Islands	NOP
IN-AN-03	Car Nicobar	Nicobar Islands	NOP
IN-AN-04	Chainpur and Hanspuri	Andaman Islands	NOP
IN-AN-05	Great Nicobar, Little Nicobar	Nicobar Islands	NOP
IN-AN-06	Interview Island	Andaman	WLS
IN-AN-07	Jarawa Reserve (Middle and South Andaman)	Andaman Islands	NOP
IN-AN-08	Kadakachang/ Katakatchang	Andaman Islands	NOP
IN-AN-09	Land Fall Island	Andaman Islands	WLS
IN-AN-10	Little Andaman	Andaman Islands	NOP
IN-AN-11	Mahatma Gandhi Marine National Park/ Wandoor National Park	Andaman Islands	NP
IN-AN-12	Mount Diavalo and Cuthbert Bay	Andaman Islands	NOP
IN-AN-13	Mount Harriet - Shoal Bay	Andaman Islands	NP
IN-AN-14	Narcondam Island	Andaman Islands	WLS
IN-AN-15	North and South Sentinel	Andaman Islands	WLS
IN-AN-16	North Reef Island	Andaman Islands	WLS
IN-AN-17	Rani Jhansi Marine National Park	Andaman Islands	NP
IN-AN-18	Saddle Peak	Andaman Islands	NP
IN-AN-19	Tillanchong, Camorta, Katchal, Nancowry and Trinket	Nicobar Islands	WLS
Andhra Pradesh			
IN-AP-01	Coringa and Godavari Estuary	East Godavari	WLS
IN-AP-02	Horsley Hills	Chittoor	NOP
IN-AP-03	Kaundinya	Chittoor	WLS
IN-AP-04	Kolleru Lake	West Godavari, Krishna	WLS
IN-AP-05	Manjira	Medak	WLS
IN-AP-06	Nagarjuna Sagar - Srisailam Rajiv Gandhi Wildlife Sanctuary (Tiger Reserve)	-	TR
IN-AP-07	Nelapattu Bird Sanctuary	Nellore	WLS
IN-AP-08	Pakhal	Warangal	WLS
IN-AP-09	Pocharam	Medak and Nizamabad	WLS
IN-AP-10	Pulicat Lake	Nellore	WLS
IN-AP-11	Rollapadu	Kurnool	WLS
IN-AP-12	Sri Lankamalleshwara	Cuddapah	WLS
IN-AP-13	Sri Penusila Narasimha	Nellore and Cuddapah	WLS
IN-AP-14	Sri Venkateswara	Chittoor and Cuddapah	NP
IN-AP-15	Telineelapuram	Srikakulam	NOP
IN-AP-16	Uppalapaddu	Guntur	NOP
Arunachal Pradesh			
IN-AR-01	Chaglagaum - Denning - Walong	Lohit	NOP
IN-AR-02	Chayang Tajo - Khenewa - Bameng	East Kameng	NOP
IN-AR-03	D'Ering Memorial	East Siang	WLS
IN-AR-04	Dibang Reserve Forest and Adjacent Areas	Dibang Valley	NOP
IN-AR-05	Dibang	Upper Dibang Valley	WLS
IN-AR-06	Dichu/Ditchu	Lohit	NOP
IN-AR-07	Eaglenest and Sessa	West Kameng	WLS
IN-AR-08	Itanagar	Papum Pare	WLS
IN-AR-09	Kane	West Siang	WLS
IN-AR-10	Koloriang - Sarli - Damin Areas	Lower Subansiri	NOP
IN-AR-11	Magu Thingbu	Tawang	NOP
IN-AR-12	Manabum and Tengapani	Lohit	NOP
IN-AR-13	Mechuka - Monigong - Jorgging	West and Upper Siang	NOP
IN-AR-14	Mehao	Dibang Valley	WLS
IN-AR-15	Mouling	Upper, East and West Siang	NP
IN-AR-16	Nacho - Limeking - Taksing - Majha	Upper Subansiri	NOP

(NP: National Park; WLS: Wildlife Sanctuary; RF: Reserve Forest; NOP: Not Officially Protected; TR: Tiger Reserve)
For more details, refer http://www.ibcn.in/?page_id=593

IBA Code	Site Name	Districts	Status
IN-AR-17	Nafra - Lada Area	West Kameng & East Kameng	NOP
IN-AR-18	Namdapha and Kamlang	Changlang and Lohit	TR
IN-AR-19	Namsangmukh - Borduria	Tirap	NOP
IN-AR-20	Pakhui or Pakke	East Kameng	WLS
IN-AR-21	Papum Reserve Forest	East Kameng	NOP
IN-AR-22	Sangti Valley	West Kameng	NOP
IN-AR-23	Shergaon, Mandla-Phudung and Kalaktang	West Kameng	NOP
IN-AR-24	TalleyValley	Lower Subansiri	WLS
IN-AR-25	The Chapories of Lohit River	Lohit	NOP
IN-AR-26	Thungri Changlang Poshingla Complex	West Kameng	NOP
IN-AR-27	Yardi - Rabe Supse	West Siang	WLS
IN-AR-28	Zamithang - Nelya	Tawang	NOP
Assam			
IN-AS-01	Amchang Hills	Kamrup	NOP
IN-AS-02	Barail Range	Cachar/North Cachar Hills	NOP
IN-AS-03	Barnadi	Darrang	WLS
IN-AS-04	Bauwwa Beel	Hailakandi	NOP
IN-AS-05	Behali	Sonitpur	NOP
IN-AS-06	Bherjan – Borajan - Podumoni	Tinsukia	WLS
IN-AS-07	Bordoibum - Bilmukh	Dhemaji-Lakhimpur	WLS
IN-AS-08	Bordoloni - Sampora	Lakhimpur and Dhemaji	NOP
IN-AS-09	Chakrasila Complex	Dhubri/Kokrajhar	WLS
IN-AS-10	Chandubi Lake and Adjoining Areas	Kamrup	NOP
IN-AS-11	Deobali Jalah, Sialmari, Haibargaon, Khutikatia (Nagaon)	Nagaon	NOP
IN-AS-12	Dhansiri	Karbi Anglong	NOP
IN-AS-13	Dibru - Saikhowa	Tinsukia, Dibrugarh and Dhemaji	NP
IN-AS-14	Deepor Beel	Kamrup	WLS
IN-AS-15	Dum Duma, Dangori and Kumsong	Tinsukia	NOP
IN-AS-16	East and North Karbi Anglong	Karbi Anglong	WLS
IN-AS-17	Garampani, Nambor, Doigrung	Karbi Anglong and Golaghat	WLS
IN-AS-18	Gibbon (Hollongapar)	Jorhat	WLS
IN-AS-19	Habang	Karbi Anglong	NOP
IN-AS-20	Innerline, Katakhal and Barak Reserve Forests	Cachar and Hailkandi	NOP
IN-AS-21	Jamjing and Sengajan	Dhemaji	NOP
IN-AS-22	Jatinga	North Cachar Hills	NOP
IN-AS-23	Jengdia Beel and Satgaon	Kamrup	NOP
IN-AS-24	Jhanjimukh - Kokilamukh	Jorhat	NOP
IN-AS-25	Kaziranga	Golaghat, Nagaon and Sonitpur	NP
IN-AS-26	Kuarbari Dalani	Lakhimpur	NOP
IN-AS-27	Langting - Mupa	North Cachar Hills	NOP
IN-AS-28	Laokhowa and Burhachapori	Sonitpur and Nagaon	WLS
IN-AS-29	Lumding - Marat Longri	Nagon, Karbi, Anglong	WLS
IN-AS-30	Majuli	Jorhat	NOP
IN-AS-31	Manas	Barpeta and Bongaigaon	TR
IN-AS-32	Nameri	Sonitpur	NP
IN-AS-33	Orang	Darrang And Sonitpur	NP
IN-AS-34	Pabho Reserve	Lakhimpur	NOP
IN-AS-35	Pabitora	Morigaon	WLS
IN-AS-36	Pani-dihing	Sibsagar	WLS
IN-AS-37	Ripu and Chirang	Kokrajhar	NOP
IN-AS-38	Sibsagar Tanks	Sibsagar	NOP
IN-AS-39	Son Beel	Karimganj	NOP
IN-AS-40	Sonai - Rupai	Sonitpur	WLS
IN-AS-41	Subansiri	Dhemaji and Lakhimpur	NOP
IN-AS-42	Tamranga - Dalani - Bhairab Complex	Bongaigaon	NOP
IN-AS-43	Tirap - Burhidihing	Tinsukia	NOP
IN-AS-44	Upper Dihing (East Complex)	Tinsukia	NOP
IN-AS-45	Upper Dihing (West Complex)	Dibrugarh, Tinsukia and Sivasagar	NOP
IN-AS-46	Urpod Beel	Goalpara	NOP
Bihar			
IN-BR-01	Chaurs of North Bihar	Darbhanga	NOP
IN-BR-02	Danapur Cantonment Area	Patna	NOP
IN-BR-03	Gogabil Pakshi Vihar, Baghar Beel and Baldia Chaur	Katihar	NOP
IN-BR-04	Kawar (Kabar) Lake	Begusarai	WLS
IN-BR-05	Kurseala River Course and Diyara Floodplain	Kathiar	NOP
IN-BR-06	Kusheshwarsthan	Darbhanga	NOP

IBA Code	Site Name	Districts	Status
IN-BR-07	Mokama Taal (Barah) Wetlands	Patna, Samastipur and Begusarai	NOP
IN-BR-08	Nagi Dam and Nakti Dam	Jamui	WLS
IN-BR-09	Reservoirs of Chhota Nagpur Plateau	Dhanbad, Hazaribagh and Gaya	NOP
IN-BR-10	Valmiki Tiger Reserve and Saraiyaman Lake	West Champaran	TR
IN-BR-11	Vikramshila Gangetic Dolphin	Bhagalpur	WLS
Chattisgarh			
IN-CT-01	Barnawapara	Raipur	WLS
IN-CT-02	Gomarda	Raipur	WLS
IN-CT-03	Indravati	Dantewada, Bastar	TR
IN-CT-04	Udanti and Sitanadi	Raipur, Dhamtari	WLS
Delhi			
IN-DL-01	Okhla	Gautam Buddh Nagar	WLS
Goa			
IN-GA-01	Bhagwan Mahavir	South Goa	WLS
IN-GA-02	Carambolim	North Goa	NOP
IN-GA-03	Cotigao	South Goa	WLS
IN-GA-04	Mhadei Wildlife Sanctuary and River Basin Forest Area	North Goa	WLS
Gujarat			
IN-GJ-01	Banni Grassland and Chhari Dhand	Kachchh	NOP
IN-GJ-02	Bhal Area	Bhavnagar and Ahmedabad	NOP
IN-GJ-03	Charakla Saltworks	Jamnagar	NOP
IN-GJ-04	Flamingo City	Kachchh	WLS
IN-GJ-05	Gir	Junagadh and Amreli	NP
IN-GJ-06	Kaj Lake (Pipalava Bandharo)	Junagadh	NOP
IN-GJ-07	Khijadiya	Jamnagar	WLS
IN-GJ-08	Marine National Park and Wildlife Sanctuary	Jamnagar	NP
IN-GJ-09	Nal Sarovar	Ahmedabad, Surendranagar	WLS
IN-GJ-10	Naliya	Kachchh	WLS
IN-GJ-11	Rampura Grassland	Panchmahals	NOP
IN-GJ-12	Salt Pans of Bhavnagar	Bhavnagar	NOP
IN-GJ-13	Thol Lake	Mehsana	WLS
IN-GJ-14	Velavadar Blackbuck National Park	Bhavnagar	NP
IN-GJ-15	Wetlands of Kheda	Kheda	NOP
IN-GJ-16	Wild Ass Sanctuary and Nanda Island	Kachchh, Rajkot, Mehsana, Banaskantha and Surendranagar	WLS
IN-GJ-17	Bhaskarpara	Surendranagar	NOP
Himachal Pradesh			
IN-HP-01	Bandli	Mandi	WLS
IN-HP-02	Chail	Solan and Shimla	WLS
IN-HP-03	Churdhar	Sirmaur	WLS
IN-HP-04	Daranghati	Shimla	WLS
IN-HP-05	Dhauladhar	Kangra	WLS
IN-HP-06	Gamgul Siahbehi	Chamba	WLS
IN-HP-07	Govind Sagar and Naina	Bilaspur, Mandi	WLS
IN-HP-08	Great Himalayan	Kullu	NP
IN-HP-09	Kais	Kullu	WLS
IN-HP-10	Kalatop Khajjiar	Chamba	WLS
IN-HP-11	Kanawar	Kullu	WLS
IN-HP-12	Kibber	Lahaul, Spiti	WLS
IN-HP-13	Kugti	Chamba	WLS
IN-HP-14	Lippa Asrang	Kinnaur	WLS
IN-HP-15	Majathal	Solan, Shimla	WLS
IN-HP-16	Manali	Kullu	WLS
IN-HP-17	Nargu	Mandi	WLS
IN-HP-18	Pin Valley	Lahaul, Spiti	NP
IN-HP-19	Pong Dam Lake	Kangra	WLS
IN-HP-20	Rupi Bhabha	Kinnaur	WLS
IN-HP-21	Sangla (Raksham Chitkul)	Kinnaur	WLS
IN-HP-22	Sarah Valley, Lower Dharamshala	Kangra	NOP
IN-HP-23	Sechu Tuan Nala	Chamba	WLS
IN-HP-24	Shikari Devi	Mandi	WLS
IN-HP-25	Shimla Water Catchment	Shimla, Kufri	WLS
IN-HP-26	Talra	Shimla	WLS
IN-HP-27	Tirthan	Kullu	WLS
Haryana			
IN-HR-01	Basai Wetlands	Gurgaon	NOP

IBA Code	Site Name	Districts	Status
IN-HR-02	Bhindawas	Rohtak	WLS
IN-HR-03	Kalesar	Kurukshetra	WLS
IN-HR-04	Sultanpur	Gurgaon	NP
IN-HR-05	Wetlands of Yamuna	Yamuna Nagar	NOP
Jharkhand			
IN-JH-01	Hazaribagh and North Karanpur Valley	Hazaribagh	WLS
IN-JH-02	Palamau	Palamau	TR
IN-JH-03	Udhuwa Lake	Sahebganj	WLS
Jammu and Kashmir			
IN-JK-01	Chushul Marshes	Leh, Ladakh	NOP
IN-JK-02	Dachigam	Srinagar and Anantnag	NP
IN-JK-03	Dehra Gali Forest	Poonch, Rajouri	NOP
IN-JK-04	Gulmarg	Baramulla	WLS
IN-JK-05	Haigam Rakh (Marshes)	Baramulla	NOP
IN-JK-06	Hanle Plains (Hanle River Marshes)	Leh, Ladakh	NOP
IN-JK-07	Hemis	Ladakh	NP
IN-JK-08	Hirapora	Pulwama	WLS
IN-JK-09	Hokarsar	Budgam and Srinagar	NOP
IN-JK-10	Kishtwar	Doda	NP
IN-JK-11	Lachipora	Baramulla	WLS
IN-JK-12	Limber Valley and Reserve	Baramulla	WLS
IN-JK-13	Mirgund Jheel and Reserve	Budgam	NOP
IN-JK-14	Overa - Aru	Anantnag	WLS
IN-JK-15	Pangong Tso	Leh, Ladakh	NOP
IN-JK-16	Ramnagar	Jammu	WLS
IN-JK-17	Shallabugh Conservation Reserve	Srinagar	NOP
IN-JK-18	Tso Kar Basin	Leh, Ladakh	NOP
IN-JK-19	Tso Morari Lake and Adjacent Marsh	Leh	NOP
IN-JK-20	Wular Lake	Baramulla	NOP
IN-JK-21	Gharana Wetland Reserve	Jammu	NOP
Karnataka			
IN-KA-01	Adichunchunagiri	Mandya	WLS
IN-KA-02	Anshi	Uttar Kannada	NP
IN-KA-03	Bandipur	Mysore	TR
IN-KA-04	Bannerghatta	Bangalore	NP
IN-KA-05	Bhadra	Chikmagalur, Shimoga	TR
IN-KA-06	Bhimgad and Castle Rock	Belgaum, North Kanara	NOP
IN-KA-07	Biligiri Rangaswamy Temple	Chamarajanagar	WLS
IN-KA-08	Brahmagiri	Kodagu	WLS
IN-KA-09	Cauvery	Mysore, Bangalore, Mandya	WLS
IN-KA-10	Dandeli	Uttar Kannada	WLS
IN-KA-11	Gudavi	Shimoga	WLS
IN-KA-12	Hampi	Bellary	NOP
IN-KA-13	Jogimatti State Forest	Chitradurga	NOP
IN-KA-14	Karanji Tank	Mysore	NOP
IN-KA-15	Kemmangundi and Bababudan Hills	Chikmagalur	NOP
IN-KA-16	Kemphole	Hassan and Dakshina Kannada	NOP
IN-KA-17	Kokkare Bellur	Mandya	NOP
IN-KA-18	Krishnarajasagar Reservoir	Mysore and Mandya	NOP
IN-KA-19	Kudremukh	Chikmagalur	NP
IN-KA-20	Kukkarahalli Tank	Mysore	NOP
IN-KA-21	Kunthur - Kallur Lakes	Chamarajanagar	NOP
IN-KA-22	Ligambudhi Lake and Environs	Mysore	NOP
IN-KA-23	Magadi and Shetikere Wetlands	Gadag	NOP
IN-KA-24	Melkote Temple	Mandya	WLS
IN-KA-25	Nagarahole	Mysore, Kodagu	NP
IN-KA-26	Nandi Hills	Kolar	NOP
IN-KA-27	Narasambudhi Lake	Mysore	NOP
IN-KA-28	Pushpagiri	Kodagu and Dakshina Kannada	WLS
IN-KA-29	Ramanagara Reserve Forest	Bangalore Rural	NOP
IN-KA-30	Ranebennur Blackbuck	Dharwad (Divided - Havery)	WLS
IN-KA-31	Ranganathittu Bird Sanctuary	Mysore	WLS
IN-KA-32	Sharavathi Valley	Shimoga	WLS
IN-KA-33	Someshwara	Udipi	WLS
IN-KA-34	Sulekere Lake	Mandya	NOP
IN-KA-35	Talakaveri	Kodagu	WLS

IBA Code	Site Name	Districts	Status
IN-KA-36	Arabhithittu	Mysore	WLS
IN-KA-37	Shettihalli	Shimoga	WLS
Kerala			
IN-KL-01	Amarambalam - Nilambur	Malapuram	NOP
IN-KL-02	Aralam	Kannur	WLS
IN-KL-03	Chimmony	Thrissur	WLS
IN-KL-04	Chinnar	Idukki	WLS
IN-KL-05	Eravikulam	Idukki	NP
IN-KL-06	Idukki	Idukki	WLS
IN-KL-07	Kattampally	Kannur	NOP
IN-KL-08	Kole	Thrissur and Malappuram	NOP
IN-KL-09	Konni	Kollam and Pathanamthitta	NOP
IN-KL-10	Kottiyoor	Kannur	NOP
IN-KL-11	Kulathupuzha	Kollam	NOP
IN-KL-12	Nelliyampathy (Nemmara Division)	Palghat	NOP
IN-KL-13	Neyyar	Thiruvananthapuram	WLS
IN-KL-14	Parambikulam	Palghat	WLS
IN-KL-15	Peechi - Vazhani	Thrissur	WLS
IN-KL-16	Peppara	Trivandrum	WLS
IN-KL-17	Periyar	Idukki	TR
IN-KL-18	Ranni	Kollam	NOP
IN-KL-19	Shendurney	Kollam	WLS
IN-KL-20	Silent Valley	Palakaad	NP
IN-KL-21	Thattekkad	Idukki	WLS
IN-KL-22	Vazhachal Forest Division	Thrissur and Ernakulam	NOP
IN-KL-23	Vembanad Lake	Ernakulam, Alleppey, Kottayam, and Pathanamthitta	NOP
IN-KL-24	Wynaad	Wynaad	WLS
Lakshadweep			
IN-LD-01	Pitti Island	Lakshadweep Islands	NOP
Maharashtra			
IN-MH-01	Bhimashankar	Pune, Raigad, Thane	WLS
IN-MH-02	Burnt Island (Vengurla Rocks)	Sindhudurg	NOP
IN-MH-03	Gangapur Dam and Grassland	Nashik	NOP
IN-MH-04	INS Shivaji and Adjoining Areas, Lonavla	Pune and Raigad	NOP
IN-MH-05	Jaikwadi Bird Sanctuary	Ahmednagar and Aurangabad	WLS
IN-MH-06	Jawaharlal Nehru Bustard Sanctuary (Nannaj) and other grassland plots	Solapur, Ahmednagar	WLS
IN-MH-07	Koyna	Satara	WLS
IN-MH-08	Mahul - Sewri Mudflats	Mumbai	NOP
IN-MH-09	Melghat Tiger Reserve	Amravati	TR
IN-MH-10	Nagzira	Bhandara	WLS
IN-MH-11	Nandur Madhmeshwar	Nashik	WLS
IN-MH-12	Navegaon	Bhandara	NP
IN-MH-13	Ozar, Wani and Adjoining Grassland	Nashik	NOP
IN-MH-14	Radhanagari	Kolhapur	WLS
IN-MH-15	Sanjay Gandhi National Park and Tungareshwar Complex	Mumbai and Thane	NP
IN-MH-16	Tadoba - Andheri	Chandrapur	TR
IN-MH-17	Taloda	Nandurbar	NOP
IN-MH-18	Tansa	Thane	WLS
IN-MH-19	Thane Creek	Mumbai, Thane	NOP
IN-MH-20	Toranmal	Nandurbar	NOP
Meghalaya			
IN-ML-01	Balpakram Complex	South Garo Hills	NP
IN-ML-02	Mawphlang Sacred Grove	East Khasi Hills	NOP
IN-ML-03	Nokrek	East, West and South Garo Hills	NP
IN-ML-04	Nongkhyllem	Ri-Bhoi	WLS
IN-ML-05	Norpuh/Narpuh	Jaintia Hills	NOP
IN-ML-06	Riat Khwan - Umiam Lake	East Khasi Hills and Ri-Bhoi	NOP
IN-ML-07	Saipung	Jaintia Hills	NOP
IN-ML-08	Upper Shillong	East Khasi Hills	NOP
IN-ML-09	Cherrapunjee: Cliffs, Gorges And Sacred Groves	East Khasi Hills	NOP
Manipur			
IN-MAN-01	Ango or Anko Hills	Ukhrul	NOP
IN-MAN-02	Bunning	Tamenglong	WLS
IN-MAN-03	Dzuku Valley	Senapati	NOP

IBA Code	Site Name	Districts	Status
IN-MAN-04	Jiri - Makru	Imphal East and Tamenglong	WLS
IN-MAN-05	Kailam	Churachandpur	WLS
IN-MAN-06	Loktak Lake and Keibul Lamjao	Bishnupur and Imphal West	NP
IN-MAN-07	Shiroi Community Forest	Ukhrul	NOP
IN-MAN-08	Yangoupokpi - Lokchao	Chandel	WLS
IN-MAN-09	Zeilad Lake	Tamenglong	WLS
Madhya Pradesh			
IN-MP-01	Bandhavgarh	Shahdol	TR
IN-MP-02	Barna Reservoir	Raisen	NOP
IN-MP-03	Bhoj (Upper Lake) Wetland	Bhopal	NOP
IN-MP-04	Bori	Hoshangabad	WLS
IN-MP-05	Dihaila Jheel and Other Wetlands	Shivpuri	NOP
IN-MP-06	Gandhisagar Reservoir	Neemuch, Mandsaur	NOP
IN-MP-07	Ghatigaon	Gwalior	WLS
IN-MP-08	Halali Reservoir	Bhopal, Raisen	NOP
IN-MP-09	Kanha	Mandla and Balaghat	TR
IN-MP-10	Madhav	Shivpuri	NP
IN-MP-11	Panna	Panna, Chhattarpur	TR
IN-MP-12	Pench	Seoni and Chhindwara	TR
IN-MP-13	Rangawa Reservoir	Chhattarpur	NOP
IN-MP-14	Ratapani	Raisen, Sehore	WLS
IN-MP-15	Sailana Kharmor	Ratlam	WLS
IN-MP-16	Sardarpur	Dhar	WLS
IN-MP-17	Yeshwantsagar Reservoir	Indore	NOP
Mizoram			
IN-MZ-01	Blue Mountain (Phawngpui)	Saiha	NP
IN-MZ-02	Dampa	Mamit	TR
IN-MZ-03	Lengteng	Champhai	WLS
IN-MZ-04	Murlen	Champhai	NP
IN-MZ-05	Ngengpui	Lawngtlai	WLS
IN-MZ-06	Palak Dil	Saiha	NOP
Nagaland			
IN-NL-01	Fakim and Saramati Area	Tuensang (Kiphire)	WLS
IN-NL-02	Intanki	Peren	NP
IN-NL-03	Khonoma Nature Conservation and Tragopan Sanctuary	Kohima	WLS
IN-NL-04	Mount Paona	Peren	NOP
IN-NL-05	Mount Zanibu	Phek	NOP
IN-NL-06	Mount Ziphu	Phek	NOP
IN-NL-07	Pfutsero - Chizami	Phek	NOP
IN-NL-08	Puliebadze - Dzukou - Japfu	Kohima	WLS
IN-NL-09	Satoi Range	Zunheboto and Phek	NOP
Orissa			
IN-OR-01	Bhitarkanika	Kendrapara	NP
IN-OR-02	Chandaka - Dampara	Khurda and Cuttack	WLS
IN-OR-03	Nalabana Bird Sanctuary (Chilika Lake)	Khurda, Puri and Ganjam	NP
IN-OR-04	Mangaljodi	Khurda	NOP
IN-OR-05	Satkosia Gorge	Dhenkanal, Cuttack, Puri, Phulbani	WLS
IN-OR-06	Simlipal	Mayurbhanj	TR
IN-OR-07	Sunabeda	Nuapada	WLS
Punjab			
IN-PB-01	Harike Lake	Amritsar, Kapurthala and Firozpur	WLS
IN-PB-02	Kanjli Lake	Kapurthala, Amritsar	NOP
IN-PB-03	Ropar Lake	Ropar	NOP
Pondicherry			
IN-PY-01	Bahour Lake	Pondicherry	NOP
IN-PY-02	Ousteri Lake	Pondicherry	NOP
Rajasthan			
IN-RJ-01	Alniya Dam	Kota	NOP
IN-RJ-02	Bardha Dam Reservoir	Bundi	NOP
IN-RJ-03	Desert	Jaisalmer and Barmer	NP
IN-RJ-04	Diyatra	Bikaner	NOP
IN-RJ-05	Gagwana Arain, Mangliyawas, Ramsar, Goyal, Ratakot and Bandar	Ajmer	NOP
IN-RJ-06	Jaisamand Lake	Udaipur	WLS

IBA Code	Site Name	Districts	Status
IN-RJ-07	Keoladeo National Park and Ajan Bandh	Bharatpur	NP
IN-RJ-08	Khichan	Jodhpur	NOP
IN-RJ-09	Kumbalgarh	Udaipur, Pali, Rajsamand	WLS
IN-RJ-10	Mount Abu	Sirohi	WLS
IN-RJ-11	National Chambal Gharial Sanctuary	Kota, Bundi	WLS
IN-RJ-12	Phulwari	Udaipur	WLS
IN-RJ-13	Ram Sagar Lake	Bundi	NOP
IN-RJ-14	Ranthambore	Sawai Madhopur	TR
IN-RJ-15	Sajjangarh	Udaipur	WLS
IN-RJ-16	Sambhar Lake	Nagaur, Jaipur, Ajmer	NOP
IN-RJ-17	Sareri Bandh	Bhilwara	NOP
IN-RJ-18	Sariska	Alwar	TR
IN-RJ-19	Sei Dam Reservoir and Environs	Udaipur	NOP
IN-RJ-20	Sitamata	Chittorgarh, Udaipur	WLS
IN-RJ-21	Sonkhaliya Closed Area	Ajmer	NOP
IN-RJ-22	Tal Chhapar	Churu	WLS
IN-RJ-23	Udaipur Lake Complex (Pichola, Interconnecting Water Bodies and Fatehsagar)	Udaipur	NOP
IN-RJ-24	Baghdarrah Closed Area	Udaipur	NOP
Sikkim			
IN-SK-01	Barsey Rhododendron	West Sikkim	WLS
IN-SK-02	Dombang Valley - Lachung - Lema Tsungthang	North Sikkim	NOP
IN-SK-03	Fambong Loh WLS - Himalayan Zoological Park - Ratey Chu Reserve Forest Complex	East Sikkim	WLS
IN-SK-04	Khangchendzonga	North and West Sikkim	NP
IN-SK-05	Kyongnosla Alpine Sanctuary- Tsomgo-Tamze-Chola Complex	East Sikkim	WLS
IN-SK-06	Lhonak Valley	North Sikkim	NOP
IN-SK-07	Lowland Forest of South SK (Melli- Baguwa-Kitam, Jorethang-Namchi, Sombarey)	South & West Sikkim	NOP
IN-SK-08	Maenam Wildlife Sanctuary - Tendong RF	South Sikkim	WLS
IN-SK-09	Pangolakha Wildlife Sanctuary- Zuluk - Bedang Tso - Natu La Complex	East Sikkim	WLS
IN-SK-10	Tso Lhamo Plateau - Lashar - Sebu La - Yumesamdong Complex	North Sikkim	NOP
IN-SK-11	Yumthang - Shingba Rhododendron	North Sikkim	WLS
Tamil Nadu			
IN-TN-01	Avalanche (Nilgiri)	Nilgiris (South Forest Division)	NOP
IN-TN-02	Berijam (Kodaikanal)	Dindigul	NOP
IN-TN-03	Big Tank (Peria Kanmai) and Sakkarkotai Kanmai	Ramanathapuram	NOP
IN-TN-04	Bison Swamp (Nilgiris)	Nilgiris (South Forest Division)	NOP
IN-TN-05	Cairnhill Reserve Forest (Nilgiris)	Nilgiris (South Forest Division)	NOP
IN-TN-06	Chitrangudi and Kanjirankulam	Ramanathapuram	WLS
IN-TN-07	Governor's Shola (Nilgiri)	Nilgiris (South Forest Division)	NOP
IN-TN-08	Grass Hills	Coimbatore	NOP
IN-TN-09	Gulf of Mannar Marine National Park	Ramanathapuram, Tuticorin	NP
IN-TN-10	Indira Gandhi Wildlife Sanctuary	Coimbatore	WLS
IN-TN-11	Kalakkad Mundanthurai	Tirunelveli	TR
IN-TN-12	Kaliveli Tank and Yedayanthittu Estuary	Cuddalore	NOP
IN-TN-13	Karaivetti	Tiruchchirappalli	WLS
IN-TN-14	Koonthangulam	Tirunelveli	WLS
IN-TN-15	Kothagiri - Longwood Shola	Nilgiris (North Forest Division)	NOP
IN-TN-16	Kullur Sandai Reservoir	Virudhunagar	NOP
IN-TN-17	Mudumalai	Nilgiris (Wildlife Division)	NP
IN-TN-18	Mukurthi National Park (Nilgiris)	Nilgiris (Wildlife Division)	NP
IN-TN-19	Naduvattam	Nilgiris	NOP
IN-TN-20	Point Calimere	Nagapattinam	WLS
IN-TN-21	Poomparai and Kukkal	Dindigul (Palni Hills)	NOP
IN-TN-22	Shola around Kodaikanal	Dindigul	NOP
IN-TN-23	Srivilliputhur	Virudhunagar	WLS
IN-TN-24	Suchindram, Theroor, Vembanoor	Kanyakumari	NOP
IN-TN-25	Thaishola	Nilgiri (South Forest Division)	NOP
IN-TN-26	Tirunelveli	Kanyakumari and Tirunelveli	NOP
IN-TN-27	Vandioor and Kunnathur Tanks	Madurai	NOP
IN-TN-28	Vaduvoor Lake	Tiruvarur	WLS
IN-TN-29	Vedanthangal and Karikili	Chengalpet	WLS

IBA Code	Site Name	Districts	Status
IN-TN-30	Veeeranam Lake	Cuddalore	NOP
IN-TN-31	Vettangudi Bird Sanctuary	Sivagangai	WLS
IN-TN-32	Watrap Periakulam and Virakasamuthrakulam	Virudhunagar	NOP
IN-TN-33	Wellington Reservoir	Cuddalore	NOP
IN-TN-34	Muthukuzhi	Nagercoil	NOP
Tripura			
IN-TR-01	Gumti WLS	Dhalai and South Tripura	WLS
IN-TR-02	Trishna	South T Tripura	WLS
Uttar Pradesh			
IN-UP-01	Bakhira	Sant Kabir Nagar	WLS
IN-UP-02	Dudhwa	Lakhimpur-Kheri	NP
IN-UP-03	Hastinapur	Bijnor	WLS
IN-UP-04	Katerniaghat Wildlife Sanctuary and Girijapuri Reservoir	Bahraich	WLS
IN-UP-05	Kishanpur	Lakhimpur Kheri	WLS
IN-UP-06	Kudaiyya Marshland	Mainpuri	NOP
IN-UP-07	Kurra Jheel	Etawah, Mainpuri	NOP
IN-UP-08	Lagga - Bagga	Pilibhit	NOP
IN-UP-09	Lakh Bahosi	Farrukhabad	WLS
IN-UP-10	Narora	Bulandshahr	NOP
IN-UP-11	National Chambal	Agra, Etawah	WLS
IN-UP-12	Nawabganj	Unnao	WLS
IN-UP-13	Parvati Aranga	Gonda	WLS
IN-UP-14	Patna	Etah	WLS
IN-UP-15	Pyagpur and Sitadwar Jheels	Bahraich	NOP
IN-UP-16	Saman	Mainpuri	WLS
IN-UP-17	Samaspur	Raebareli	WLS
IN-UP-18	Sandi	Hardoi	WLS
IN-UP-19	Sarsai Nawar Lake	Etawah	NOP
IN-UP-20	Sauj Lake	Mainpuri	NOP
IN-UP-21	Sheikha Jheel	Aligarh	NOP
IN-UP-22	Sohagibarwa	Maharajganj	WLS
IN-UP-23	Soheldev	Balrampur	WLS
IN-UP-24	Sur Sarovar	Agra	WLS
IN-UP-25	Surha Taal	Ballia	WLS
Uttarakhand			
IN-UT-01	Asan Barrage	Dehradun	NOP
IN-UT-02	Askot Wildlife Sanctuary and Goriganga Basin	Pithoragarh	WLS
IN-UT-03	Binog - Bhadraj - Jharipani	Dehradun	WLS
IN-UT-04	Binsar	Almora	WLS
IN-UT-05	Corbett	Pauri Garhwal and Nainital	TR
IN-UT-06	Govind National Park and Wildlife Sanctuary, Sandra, Kotinad and Singtur Ranges	Uttarkashi	NP
IN-UT-07	Kedarnath Musk Deer Sanctuary and Reserve Forests	Chamoli	WLS
IN-UT-08	Nanda Devi	Chamoli and Bageshwar	NP
IN-UT-09	New Forest Campus	Dehradun	NOP
IN-UT-10	Rajaji	Dehradun, Haridwar and Pauri Garhwal	NP
IN-UT-11	Sonanadi	Garhwal, Bijnor	WLS
IN-UT-12	Upper Pindar Catchment Area	Almora	NOP
IN-UT-13	Valley of Flowers	Chamoli	NP
IN-UT-14	Gangotri	Uttarkashi	NP
West Bengal			
IN-WB-01	Buxa	Jalpaiguri	TR
IN-WB-02	Farakka Barrage and Adjoining Area	Malda	NOP
IN-WB-03	Gorumara	Jalpaiguri	NP
IN-WB-04	Jaldapara	Jalpaiguri	WLS
IN-WB-05	Kulik (Raiganj) Bird Sanctuary	Uttar Dinajpur	WLS
IN-WB-06	Lava - Neora Valley	Darjeeling and Jalpaiguri	NP
IN-WB-07	Mahananda	Darjeeling	WLS
IN-WB-08	Naya Bandh Wetland Complex	Malda	NOP
IN-WB-09	Singhalila	Darjeeling	NP
IN-WB-10	Sundarban	North and South 24-Parganas	TR

Annexure III
Threatened Bats of India
(Source: IUCN 2013, Molur *et al.* 2002, Srinivasulu 2010)

Sr. No.	Species name	IUCN category	Range description
1	Durga Das's Leaf-nosed Bat *Hipposideros durgadasi* Khajuria, 1970	EN	Jabalpur, MP
2	Leafletted Leaf-nosed Bat *Hipposideros hypophyllus* Kock & Bhat, 1994	EN	Kolar, Karnataka
3	Sálim Ali's Fruit Bat *Latidens salimalii* Thonglongya, 1972	EN	Periyar Tiger Reserve, Kerala Kalakkad-Mundunthurai and Tiger Reserve, Kardana Coffee Estate, Meghamalai, High Wavy Mountains in Tamil Nadu
4	Andaman Horseshoe Bat *Rhinolophus cognatus* Andersen, 1906	EN	Andaman
5	Mandelli's Mouse-eared Bat *Myotis sicarius* Thomas, 1915	VU	Sikkim, West Bengal
6	Nicobar Flying Fox *Pteropus faunulus* Miller, 1902	VU	Nicobar Islands
7	Blyth's Flying Fox *Pteropus melanotus* Blyth, 1863	VU	Andaman and Nicobar Islands
8	Large Flying Fox *Pteropus vampyrus* Linnaeus, 1758	NT	Probably Andaman and Nicobar Islands
9	Sombre Bat *Eptesicus tatei* Ellerman and Morrison-Scott, 1951	DD	Darjeeling, West Bengal
10	Peter's Tube-nosed Bat *Harpiola grisea* Peters, 1872	DD	Sairep in Mizoram and Jairipanee in Mussoorie, Uttarakhand
11	Rufous Tube-nosed Bat *Murina leucogaster* Milne-Edwards, 1872	DD	North East India
12	Kashmir Cave Bat *Myotis longipes* Dobson, 1873	DD	Jammu & Kashmir, and Meghalaya
13	Wroughton's Free-tailed Bat *Otomops wroughtoni* Thomas, 1913	DD	Barapede Cave near Talewadi, Belagavi district, Karnataka and Nongtrai village, Shella Confederacy, Meghalaya
14	Mitred Horseshoe Bat *Rhinolophus mitratus* Blyth, 1844	DD	Chaibassa in Jharkhand

(EN: Endangered; VU: Vulnerable; NT: Near Threatened, DD: Data Deficient)

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Demoiselle Crane *Grus virgo*
Photo by: Asif N. Khan

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